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A MANUAL OF DISEASES
OF THE
NOSE, THROAT, AND EAR

BY

E. B. GLEASON, M.D., LL.D.
Professor of Otology, Medico-Chirurgical College Graduate School,
University of Pennsylvania

FOURTH EDITION, THOROUGHLY REVISED

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W. B. SAUNDERS COMPANY
1918

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TO

Hon. Henry F. Walton,

A LEARNED, GENIAL GENTLEMAN
AND
A GOOD FRIEND

IN AFFECTIONATE APPRECIATION OF HIS MANY ACTS
OF KINDNESS AND WORDS OF WISE COUNSEL
THIS LITTLE BOOK IS INSCRIBED

BY

THE AUTHOR

PREFACE TO THE FOURTH EDITION

The Third Edition has been carefully revised, and all that seemed obsolete or likely to become so eliminated in an effort to secure space for the numerous additions necessary to bring the present volume up to date without greatly increasing the number of pages. To do this efficiently required more work than to write a larger book.

Whenever an important anatomic fact has been newly demonstrated, or a novel and practical theory as regards the physiology or pathology of the upper respiratory tract or ear has been published, it has received brief but careful consideration, but the author has been careful not to give undue prominence to the fads of fanatics or extremists, because experience proves that much of that which is sometimes called "advanced standing" finally becomes medical junk.

Whenever a condition for which operations are sometimes done is amenable to treatment, description of the treatment receives the more careful elaboration, because this edition, like its predecessors, is designed not as a book of reference for specialists, but for general practitioners and the beginners in Laryngology and Otology. The author feels that the amount of time and attention that is devoted to operation in postgraduate teaching and the amount of space in text-books given to the elaboration of many operations for the same pathologic condition, most of the operations differing from each other only as regards trifling details of technic, but each labeled with the name of the inventor, is calculated to foster the erroneous impression on the mind of the beginner that there is no adequate treatment for the condition except operation. As a matter of fact, the ultimate tendency of the surgery of any region is toward conservatism. This is well exemplified in the military surgery of recent wars. The War of the Rebellion was so radical that he who did the most amputations, or radical operations, was the greatest surgeon; while the present war is characterized by a conservatism that seeks to preserve the wounded limb by the most careful and exacting of antiseptic treatment and plastics.

In otology, ossiculotomy in catarrhal cases and some other intratympanic operations are no longer done, and the space in former editions devoted to them has been used for other subjects. There is considerable criticism of the end-results obtained by the average operator by radical operations on the mastoid and nasal accessory sinuses. As a general rule, the surgeon should be careful about performing destructive operations unless the indications are urgent if the end-results are simply the substitution of one pathologic condition for another, lest the "cure be worse than the disease," as has undoubtedly been the case after some radical operations on the mastoid and accessory nasal sinuses.

In describing operations only those are chosen that might be called "standard," and which, because of their uncomplicated tèchnic, are most likely to prove successful in the hands of the average operator. This has the advantage that it leaves to the individual teacher the opportunity to impress on a student, who may have read this book, his own technic without the student being obliged to ignore minor details that he has absorbed from his reading.

For example, but two methods of tonsillectomy are described; that of Sluder is not mentioned because it is not the operation of choice in most types of tonsil; while "circumcision" is mentioned as worthy of trial in adults and as a substitute for tonsillectomy in singers and those whose main symptom is a sense of irritation in the pharynx.

For the correction of deviation of the nasal septum only submucous resection has received a lengthy description.

Considerable space is devoted to the diagnosis of diseases of the internal ear and related intracranial conditions by means of turning, caloric and galvanic tests, and an effort has been made to render descriptions sufficiently simple to not complicate and render more difficult this interesting subject; so that it is hoped that the average student by careful reading of this section will have a clear comprehension of at least the underlying principles.

The formulary at the end of the book has received careful attention. Some new drugs have been added and newer methods of using the older drugs substituted for those formerly employed.

E. B. GLEASON.

2033 CHESTNUT STREET,
PHILADELPHIA, PA.

August, 1918.

PREFACE

This manual was written to supply students and general practitioners with the essential facts of Rhinology, Laryngology, and Otology in as concise a form as possible.

The more important facts of the anatomy, physiology, and pathology of the upper respiratory tract and ear have received careful consideration, so that the volume might prove sufficiently complete for study or reference by undergraduates during their college years and for practitioners taking a post-graduate course in laryngology and otology.

The details of inspection, examination, and diagnosis of the nose, throat, and ear conditions and the use of the commoner instruments of diagnosis and for the making of applications have received very careful and comparatively lengthy detailed description. The same may be said of minor operations. Methods of treatment have been simplified as much as possible, so that in most instances only those methods, drugs, and operations have been advised which, by the actual experience of the author, have proved essential to the accomplishment of the desired result. At the end of the book is a collection of Formulas designed to represent more than a mere catalogue of prescriptions. Hence a detailed description of the better methods of use of each of the more important drugs has been interpolated, which it is hoped the reader will find useful and suggestive.

The history of the gradual development of some of the more important instruments, methods of treatment, and, more especially, operations has been considered of sufficient practical importance to be briefly outlined. In some instances the prognosis in cases not operated on has been accentuated by quotations from the writings of standard authors of the period before such operations were practised.

The book contains 262 engravings, a considerable proportion being original or drawn from dissections made by the author. The value of carefully made sections through the upper respiratory tract and ear for purposes of study and reference is stated and a method of preparing and preserving such specimens described.

E. B. GLEASON.

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DISEASES OF
THE NOSE, THROAT, AND EAR

THE LARYNGOSCOPE

THE laryngoscope is a combination of two mirrors arranged to enable the observer to see the interior of the larynx. The larger and concave mirror, called the reflector, is attached to the observer's head by a head-band, and the smaller and plane mirror, called the laryngeal mirror, is introduced into the back part of the mouth in such a manner as to be directly above the glottis; so that light reflected from the reflector upon the laryngeal mirror illuminates the interior of the larynx, and enables the observer to see its image in the small mirror.

In 1854 Signor Manuel Garcia, by means of a dentist's mirror and a hand-glass, *studied* the movements of his own vocal cords during phonation, and accurately described the registers of the voice in a paper read before the Royal Society of London in 1855, and hence the honor of inventing the laryngoscope is usually accorded to Garcia.

The **laryngeal mirror** consists of an oval or round piece of silvered glass, mounted in a metal frame and attached to a wire stem at an angle of about 120 degrees (Fig. 1). Such mirrors vary in size from ½ inch to 1½ inches in diameter, and are numbered 1, 2, 3, 4, 5 by instrument makers. However, smaller mirrors, Nos. 00 and 0, and larger mirrors, Nos. 6, 7, and 8, may be obtained, and are occasionally useful.

The **reflector** is a concave mirror usually 3½ inches in diameter, of about 12-inch focus, and made of silvered glass, mounted in a metal frame, so arranged that it is capable of attachment by a universal joint either to a head-band or the source of illumination.

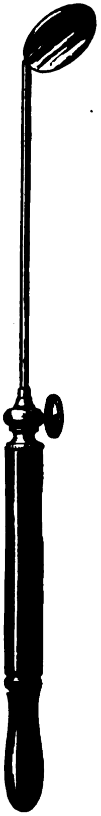


Fig. 1.—Laryngeal mirror in universal handle.

The instrument known as **Fox's head-band** (Fig. 2) consists of steel or, preferably, brass strips hinged together so that they can be folded about the mirror to protect it and form a conveniently shaped package to be carried in a pocket. When in use the head-band assumes the position of a line passing over the head from the forehead to the occiput. It is held firmly in position by the hinged bands, which when unfolded act as a spring. It has the advantage that at once it adjusts itself to heads of varying shapes and sizes, and hence is convenient in class-demonstration to pass from student to student. There are many modifications of the original model. However, a head-band of leather is lighter. The leather should be black to prevent discoloration by sweat. The joint by which the mirror is attached to the forehead is by no means a matter of indifference, a double ball-and-socket joint greatly facilitates the adjustment of the reflected light, and renders it

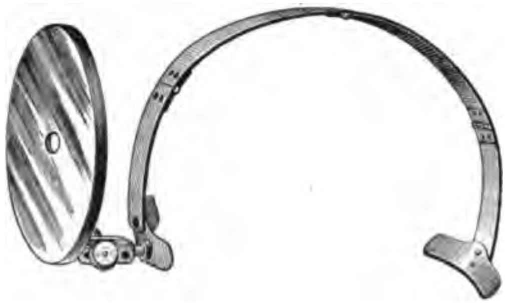


Fig. 2.—Reflector with Fox's head-band. The original head-band has been modified in various ways with the apparent object of doing away with so many joints. These modifications make a less compact package for the pocket and furnish no protection for the mirror.

possible to bring the perforation in the center of the reflector closer to the eye, a decided advantage in examining narrow cavities like the nasal passages or the auditory meatus. Some years ago the author had made for use in his class-room the head-band shown in Fig. 3. At that time his principal object was cheapness. It is light, comfortable, and efficient.

Proper Method of Wearing the Reflector.—The reflector should be adjusted so that the operator looks through the hole in its center when the light is reflected from it upon the face of the patient, so as to form a circle bounded above by the tip of the nose and below by the front of the chin. When worn over the left eye, with the source of illumination to the left of the patient, it is possible to secure a better illumination of the nose and mouth with less frequent manipulation of the reflector. If, however, the source of illumination be at the patient's right, the reflector is more conveniently worn over the right eye.

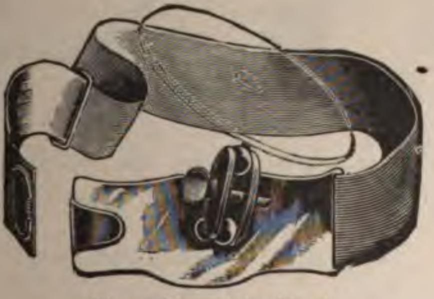


Fig. 3.—Gleason's head-band.

Sources of light used in otoscopy are natural and artificial.

Daylight, preferably that reflected from a white cloud, artificial light, furnished by a Welsbach mantle, Argand burner, oil lamp, or the electric light, may be used. Whatever the source of the illumination, the light is directed into the auditory canal, mouth, or nose by means of the reflector.

The **source of light** (Fig. 4) is best placed at the patient's right, somewhat behind him, and on a level with the top of his ear. As the heights of patients vary greatly when seated, it is well to have some means by which the position of the light can be quickly and conveniently changed. There are several forms of adjustable gas and electric brackets manufactured that answer fairly well. One that can readily be manipulated with the left hand while the operator remains seated will be found to be the most convenient.

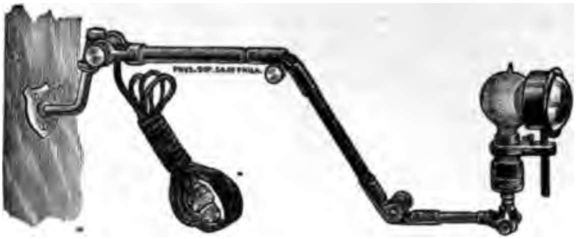


Fig. 4.—Adjustable electric wall bracket with light condenser.

THE ART OF LARYNGOSCOPY

Laryngology is the seeing and describing what is present in the larynx. The word signifies a treatise on the larynx and its diseases. **Laryngoscopy** is simply the art of viewing the interior of the larynx.

The optical law involved in laryngoscopy is that *the angle of reflection is equal to the angle of incidence.* This law is illustrated by the fact that the laryngeal mirror must be placed in the patient's pharynx, above and behind the larynx, and at such an angle that light received on its surface is reflected downward into the larynx. The rays then forming the laryngeal image will return along the same path, and be reflected at the same angle into the eye of the observer. From this it follows that the nearer the center of the head-mirror is placed to the eye of the observer, the better will the image of the larynx be seen (Fig. 5).

We should bear in mind that the laryngeal image is a reflected one, and that, therefore, it is reversed anteroposteriorly, owing to the fact that the laryngeal mirror is above and behind the opening of the larynx (Fig. 6).

The observer should sit opposite to the patient so that his eye is on a level with, and about a foot from, the mouth of the patient, whose head should be slightly raised and inclined backward. The knees of the observer should be either at the left or on either side of the patient's knees. For office use it is most convenient to have piano stools, or chairs, the seats of which can be raised or lowered, so that the difference in the heights of different patients can be compensated for, and the eye of the observer can be brought on a level with that of the patient.

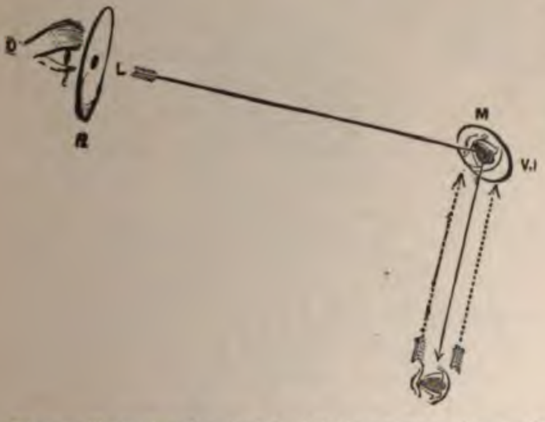


Fig. 5.—Diagram illustrating the principle of the laryngoscope (Lennox Browne).

If a head-reflector be used it is advisable for the observer first to place his head in an easy position and *then* move the reflector until the disk of reflected light falls in the opened mouth of the patient with its center at the base of the uvula, thus illuminating all the surrounding parts. This method of procedure has the very practical advantage that if the observer has to turn his head to see to pick up an instrument or for any other purpose, bringing his head back into the former easy position at once reilluminates the patient's pharynx without readjusting the reflector.

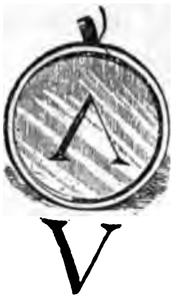


Fig. 6.—Diagram of laryngeal mirror, illustrating the reversion of the reflected image (Lennox Browne).

Introduction of Laryngeal Mirror.—The laryngeal mirror is first warmed by holding its reflecting surface over a flame for a short time to prevent moisture condensing upon it. The handle should be held between the thumb and forefinger of the right hand like a pen-holder, with the reflecting surface of the mirror downward. The forearm should be flexed upon the arm and the hand slightly backward upon the wrist and held a little below the mouth of the patient. By a forward motion of the hand and a slight raising of the arm and unbending of the elbow the mirror is quickly carried into the mouth, following the curve of the hard palate until the back of the mirror touches and raises the uvula, pressing it upward and backward as far as possible. Meanwhile the left hand of the observer has grasped the patient's protruding tongue, holding it well forward by means of a towel or napkin to prevent slipping through the fingers.

Controlling the Tongue.—The protruded tongue of the patient should be grasped between the outstretched thumb and index-finger of the left hand, protected by a napkin or towel to prevent slipping, in such a manner that the forefinger, being placed against the lower teeth, projects above their edge, and thus forms a roller upon which the tongue can move without its frenum coming in contact with the sharp edge of the lower incisors. The thumb being placed on the upper surface of the tongue and the middle finger above the chin of the patient, a slight rotatory motion of the observer's left hand will then not only control the motion of the tongue of the patient but also keep all involuntary movements of his head in check. When the operator has to use both hands in operating or making applications, the patient should be taught this maneuver and requested to hold his tongue forward himself.

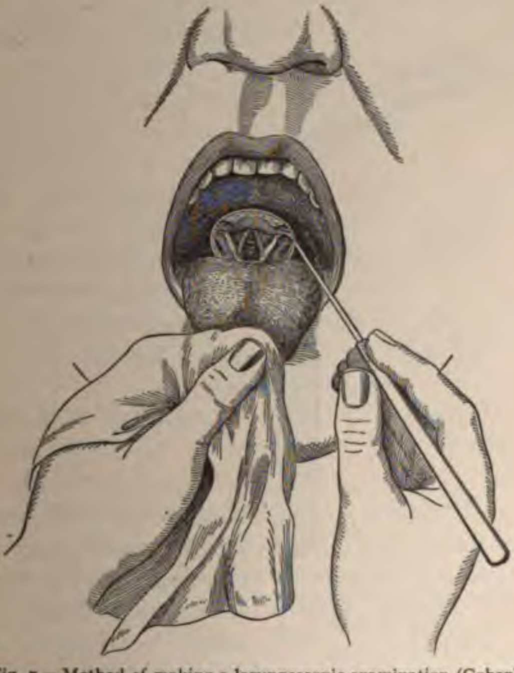


Fig. 7.—Method of making a laryngoscopic examination (Cohen).

The mirror should not touch the tongue or palate; and, when in position, it should be held steadily and not allowed to tremble, or gagging and retching will result. Should the slightest sign of this occur, the mirror must be quickly withdrawn, and only reintroduced when the patient has had time to recover his breath and confidence; or the gagging will be repeated on an attempt to reintroduce the mirror, and the throat finally become so sensitive that a further examination will be impossible at that sitting.

To bring the laryngeal image into view the handle of the mirror is brought to one side until it lays in the angle of the patient's mouth, and the hand holding it is steadied by one or two fingers resting on the cheek of the patient. This procedure brings the hand out of the line of vision. The mirror is next slowly but steadily turned until the image of the larynx appears upon its surface. The patient should now be requested to say "Ah" in order to raise the epiglottis (Fig. 7).

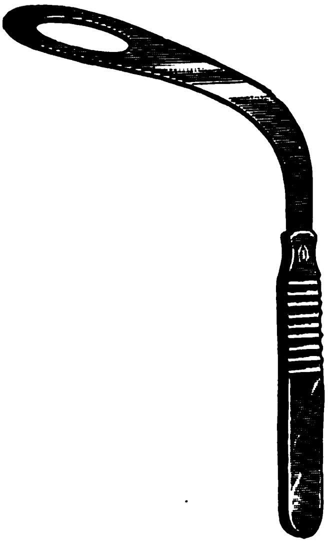


Fig. 8.—Bosworth's tongue-depressor. This is one of the most simple and convenient of numerous forms of tongue-depressors, some of which carry miniature electric lights.

Obstacles to laryngoscopy are: 1. *Irritability* of the pharynx, produced by trembling of the hand holding the mirror, causing gagging and retching. 2. Want of proper *adjustment of the light*, without which the larynx cannot be illuminated, even when the mirror is in the proper position. 3. Undue irritability or peculiar formation of certain parts of the throat. 4. Raising of the back of the tongue upon the approach of the mirror, in spite of the traction made upon its tip. 5. Too large or pendent epiglottis.

Gagging and retching can be prevented generally by avoiding to touch the tongue and palate while introducing the mirror, and by holding it steadily in its proper position when introduced. Irritability of the pharynx may be relieved by letting the patient swallow a glass of ice-water before introducing the mirror; or, if that should fail, 2 per cent. of cocain solution from an atomizer will generally produce the desired effect. If the back part of the tongue rises so as to obstruct the view in spite of traction on its tip, it may be caused to lie flat in the mouth by steady pressure with a tongue-depressor (Fig. 8). When the epiglottis is so large or pendent as to obstruct the view, the glottis sometimes can be seen by causing the patient to laugh or sing in a high pitch, or pronounce the syllables e-ah, e-ah.

Autolaryngoscopy.—The observer who wishes to study his own larynx should seat himself with his back toward a window through which the direct light of the sun enters. In front of him should be a plane mirror, so placed as to reflect a ray of sunlight into his open mouth. All being in readiness, he seizes his tongue with a napkin held in his left hand, and pulls it forward. His right hand now carries a laryngeal mirror to the back of the mouth, its progress being watched in the mirror before him. When properly placed, the sunlight from the plane mirror is reflected by the laryngeal mirror into the larynx, and its image appears upon the laryngeal mirror and is reflected forward upon the plane mirror, where it may be studied by the observer. Artificial light may also be used for autolaryngoscopy by having the source of illumination at one side of, on a level with, and slightly behind the observer's head; while a concave reflector is placed at one side of the plane mirror to reflect the light upon the laryngeal mirror in the back part of the mouth.

Infraglottic Laryngoscopy.—In some cases in which tracheotomy has been performed and the cannula is fenestrated, a small mirror may be so introduced into the cannula as to obtain a view of the under surface of the vocal cords, which are red instead of white. Unfortunately, the mirror must be so small that little else can usually be seen.

LARYNGEAL IMAGE

Normal Image.—At the upper part of the mirror (Figs. 9–11) is seen the reddish-yellow arch of the epiglottis (L) with its cushion (C). In front of the epiglottis and extending downward across the mirror are seen two pairs of bands—the outer red, and the inner of a pearly white. The former are the ventricular bands (P), while the latter are the vocal cords (V). In deep breathing a triangular opening is seen between the vocal cords, through which we can see into the inferior cavity of the larynx and view the anterior part of the cricoid cartilage as well as some of the tracheal rings below it (W, P). In some cases two dark circles can be seen in the depth of the trachea, indicating the openings of the bronchi (B). During tone-production the opening between the vocal cords is narrowed to a slit, and this space is called the *rima glottidis* (chink of the glottis). At the termination of the vocal cords are the arytenoid cartilages, with the interarytenoid space or commissure between them. From each side of this commissure, a fold, called the *aryepiglottic fold*, extends for-

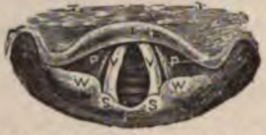
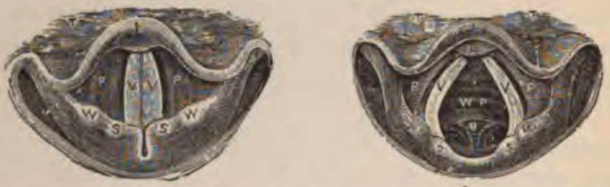


Fig. 9.—The larynx in gentle breathing (Lennox Browne).



a *b*

Fig. 10.—*a*, The larynx in tone-production; *b*, the larynx in deep breathing (Lennox Browne).

ward to join the arch of the epiglottis. Upon each of these folds are two nodules—the cartilages of Wrisberg (w) and those of Santorini (s). These latter surmount the arytenoid cartilages. Attaching the epiglottis to the tongue is seen in the mirror a light-colored band—the glosso-epiglottic fold. On each side are two grooves, called the glosso-epiglottic fossæ. The color of the mucous membrane, as seen in the laryngeal image, varies from the pearly whiteness of the vocal cords to the reddish yellow of the epiglottis and the pinkish red seen in other localities. There is also considerable variations in color, within the limits of health, in different individuals, and even in the same individual under different conditions. As seen by yellow artificial light it is always redder in color than by direct sunlight.

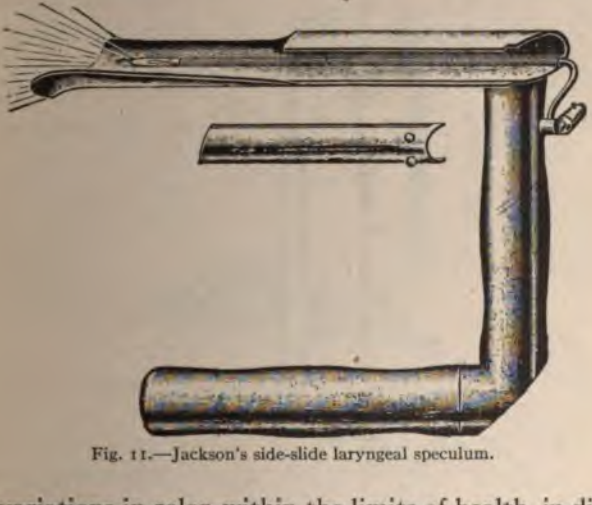


Fig. 11.—Jackson's side-slide laryngeal speculum.

Direct Laryngoscopy.—Kirstein long ago demonstrated that it was possible to get a direct view of the interior of the larynx by strong pressure on the *base of the tongue*, with a long curved tongue-depressor. His method never became popular. Killian modified the depressor into a tube with a beaked end designed to enter the vestibule of the larynx and lift the epiglottis out of view. In this manner it is possible to see the interior of the larynx with the right hand free for the intralaryngeal use of instruments.

The laryngeal surface of the epiglottis, aryepiglottic folds, and arytenoids are painted several times with 20 per cent. cocain to which an equal amount of 1 : 1000 adrenalin has been added. The patient is requested to cough and expectorate any excess of solution, and if necessary the interior of the larynx is cocainized finally in the same manner. The grooved spatula (Fig. 11) is passed over the epiglottis which is pushed forcibly against the base of the tongue to bring the interior of the larynx into view. During this procedure the patient is seated on a low stool with his head extended forward and upward; the operator standing in front. By this method it is possible to remove foreign bodies, tumors, etc., with straight instruments by direct vision.

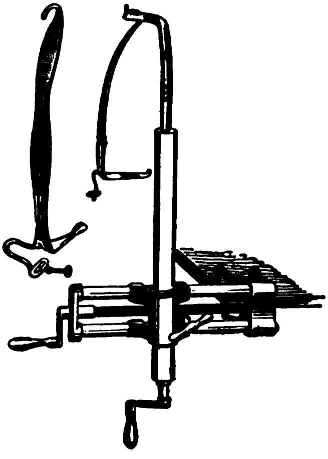


Fig. 12.—Killian's apparatus for suspension laryngoscopy.

Direct laryngoscopy has been further improved by placing the patient on his back upon an operating table and supporting his head by means of a Killian suspension laryngoscope which is clamped to the table (Fig. 12). Suspension laryngoscopy has the advantage that the operator has *both* hands free for the manipulation of instruments and has a wide field of vision with the larynx at close range so that more extensive intralaryngeal operations are possible than by the indirect method which, however, has the advantage that it is often possible to remove foreign bodies and small growths with less inconvenience to the patient than the mere introduction of the instruments necessary for direct laryngoscopy.

Direct tracheoscopy and bronchoscopy was first performed by Killian for removing foreign bodies. It is essentially the same as direct laryngoscopy except that the spatula is replaced by a tube, of a dimension corresponding to the patient's age. If done under local anesthesia, the trachea is cocainized as well as the larynx, after which the tube is passed between the cords into the trachea or bronchus. The method is also of advantage for the diagnosis and treatment of obscure lesions of the lower respiratory tract.

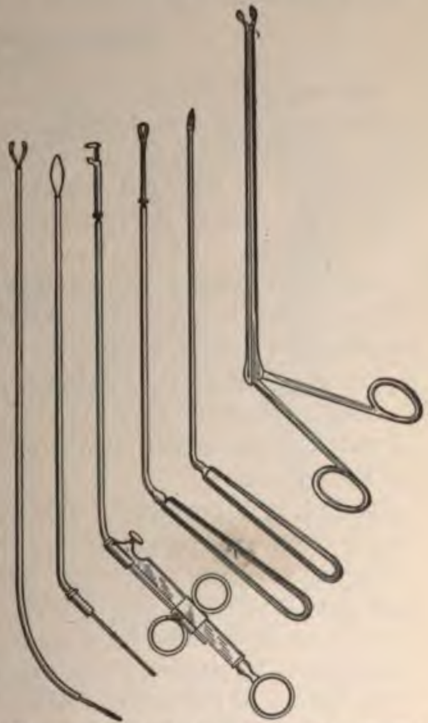


Fig. 13.—Types of instruments for autoscopic operations.

The advantages of direct laryngoscopy over the indirect are few. In cases where this epiglottis is low, omega

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shaped, it is of decided advantage, and also in cases where it is impossible to obtain with a mirror a good view of a tumor at the anterior commissure. However, those who are skilful in the indirect method generally find the direct method much more distressing to the patient. For extensive operating, there is a tendency to return to laryngofissure.

RHINOSCOPY

Rhinoscopy is the art of inspecting the nasal cavities, and may be divided into anterior and posterior rhinoscopy. Anterior rhinoscopy is the inspection of the anterior nares through the nostrils, and posterior rhinoscopy is the inspection of the vault of the pharynx and of the posterior nares from behind.

The word **nares** should be applied solely to the anterior and posterior openings of the nasal cavities. The posterior openings are sometimes called the *choanæ.*

The **postnasal space** or **nasopharynx** is the cavity bounded in front by the posterior nares or choanæ, above by the vault of the pharynx, behind by the pharyngeal wall, and below by the soft palate.

Technic of Rhinoscopy.—The simplest method of inspection is to raise the tip of the nose with a finger, and draw the ala away from the septum by means of a bent probe. If now light is reflected into the dilated nostril, the nasal cavity will be illuminated for a considerable distance, and the condition of its lining mucous membrane may be inspected. The opening of the nostril may, however, be effected more conveniently by means of a *nasal speculum,* of which there are a great variety. Of these, one of the most popular is Killian's (Fig. 14). In most noses the instrument shown in Fig. 17 cannot be displaced by facial contortions of the patient, and hence is a better speculum for operating, as it leaves both hands of the operator free. It is sometimes necessary, however, to snip away the vibrissæ before an operation in order to obtain a better view of the interior of the nose. This occupies but a moment and is a matter of little consequence.

Two sizes of the instrument should be at hand, and the spring of the instrument should be adjusted by bending until it does not cause sufficient pressure to occasion the patient pain or annoyance. The instrument is introduced by directing its blades along the floor of the nose until they have nearly disappeared within the nasal chamber, when the instrument is turned upward until it grasps and separates the rim of the nostril as an eye speculum separates the eyelids. Allen's speculum (Fig. 16) acts on the same principle, except that it widens the rim of the nostril vertically instead of horizontally.

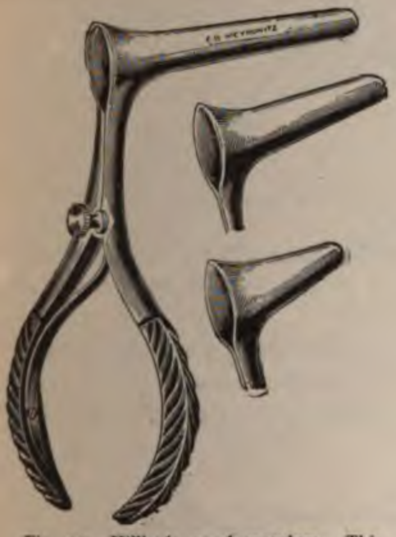

Fig. 14.—Killian's nasal speculum. This speculum is a slight modification of the Kramer ear speculum invented about 1840; the blades having been flattened to adapt it to examining the nose.

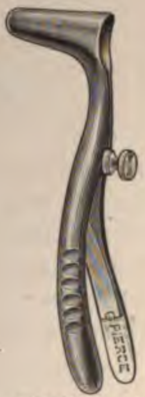

Fig. 15.—O'Reilly's modification of the Killian speculum. Sullivan has modified the shape of the blades and lengthened them in such a manner as to adapt the instrument to use in subcutaneous resections, infraction of the inferior and middle turbinates, etc.

When using a nasal speculum the instrument and patient's head should be moved in such a way that the different parts of the interior of the nose are successively brought into view. Any secretions that obstruct the view should be removed by the atomizer or forceps, or wiped away with cotton wrapped on the end of an applicator; and any change in the bulk of the parts should be tested with the probe to determine its density. If an anterior hypertrophy obstructs the view of deeper structures, cocain solution should be applied to reduce its size and allow light to penetrate into the deeper parts of the interior of the nose.

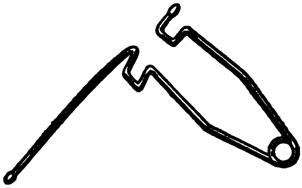

Fig. 16.—Allen's operating nasal speculum.

The first structure brought into view **by anterior rhinoscopy** is the vestibule, in which are a number of coarse hairs called vibrissæ, while a fold of skin or mucous membrane lies between the vestibule and the inferior meatus. To the inner side is the septum and to the outer side the inferior turbinated bone, forming the roof of the inferior meatus. Above the inferior turbinate is the middle meatus, roofed in above, except for the olfactory slit, by the middle turbinated body. Through the olfactory slit in some individuals a portion of the superior turbinate can be seen.

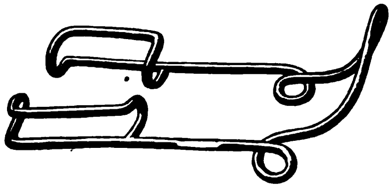

Fig. 17.—Gleason's operating nasal speculum.

Posterior rhinoscopy is, to all intents and purposes, the same process as laryngoscopy, except that a smaller mirror must generally be used, the reflecting face of which is turned upward instead of downward. The tongue, also, instead of being drawn forward with a napkin, is held down by a tongue-depressor. The relative position of patient and observer is the same as in laryngoscopy, except that the patient's head is not bent backward, but is either held perpendicularly or is inclined slightly forward. The rhinoscopic mirror, having been warmed, should be introduced into the pharyngeal cavity behind the velum palati, and so placed as to reflect the light upward and forward into the

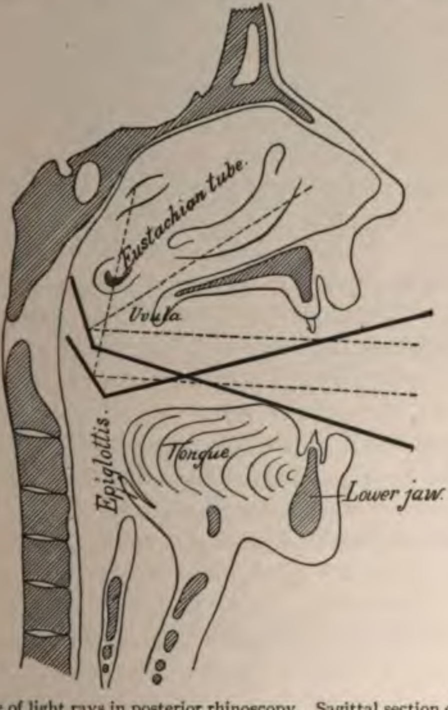

Fig. 18.—Course of light rays in posterior rhinoscopy. Sagittal section of head (Sahli).

vault of the pharynx and into the posterior nares (Fig. 18). For this purpose mirror No. 1, 0, or 00 is generally most useful, but a larger mirror can sometimes be used to advantage, and should always be employed when the space between the palate and the pharynx is sufficient to permit it. Posterior rhinoscopy is much more difficult than laryngoscopy; but, except in the case of young children, patience and dexterity will most always enable the observer to obtain a glimpse of the various parts of the posterior nares and vault of the pharynx without the use of accessory instruments. When disease of these structures exists, the examination is usually easy because of their interference with the motion of the palate and the relatively wider space between the palate and posterior pharyngeal wall.

Obstacles to Posterior Rhinoscopy.—In many cases the palate will rise forcibly as soon as the mirror has been introduced, thus completely shutting off the view of the parts above. This difficulty can often be overcome by requesting the patient to breathe through his nose, or emit a nasal sound like that of the French letter *n*, or say "One." Some operators ask their patients to snore or to "smell," that is, to draw the breath inward forcibly through the nose, as if endeavoring to perceive an odor.

The observer should in all cases avoid touching the back of the tongue or pharyngeal wall, as otherwise gagging and retching immediately occur, and further examination is rendered futile.

Posterior Rhinoscopic Image.—Except in cases of cleft palate, it is impossible to obtain a complete posterior rhinoscopic image, such as is shown in Fig. 19, but by varying the position of the mirror the different parts may be brought into view and studied one after the other. Usually the first object seen is a triangular plate, with its apex downward—the posterior margin of the nasal septum. Above it is a mass of glandular tissue—the pharyngeal tonsil—while at each side lower down are the crater-like orifices of the eustachian tube. In front of these, and projecting toward the septum, are the posterior aspects of the turbinated bones. The middle turbinated bone is usually first brought into view and rarely the dim outline of the superior turbinated bone may be distinguished above and in front of it. Below the middle turbinated bone the upper part of the inferior turbinated bone is readily perceived; but to see the lower part of this structure and the floor of the nose requires considerable practice in the use of the rhinoscopic mirror. A somewhat better view of Rosenmüller's fossæ, the eustachian tubes, and the lateral and posterior walls of the nose can be obtained with the nasopharyngoscope (Fig. 20) than with the mirror. In about 40 per cent. of cases the

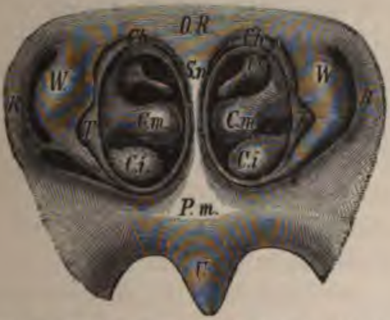

Fig. 19.—Normal picture in posterior rhinoscopy. Diagrammatic, in that to obtain a complete picture, the position of mirror must be repeatedly changed: *S.n*, Septum; *Ch.*, choana; *P.m.*, soft palate; *U.*, uvula; *C.i.*, inferior turbinate body; *C.m.*, middle turbinate body; *C.s.*, superior turbinate body; occasionally visible. Beneath each turbinated is the corresponding fossa. *O.R.*, roof of pharynx; *T.*, opening of eustachian tube; *W.*, promontory of tube; *R.*, Rosenmüller's fossa. (After Schnitzler.)

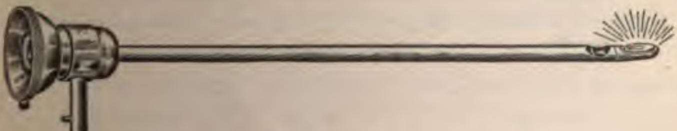

Fig. 20.—Holmes' nasopharyngoscope.

ostea of the sphenoid sinuses are visible and frequently the ostea of ethmoid cells.

OTOSCOPY

Otoscopy is the art of inspecting the visible parts of the ear. Ordinarily these parts are the auricle, the external auditory meatus, and the outer surface of the membrana tympani. Deeper portions of the ear are, however, visible when the overlying structures are destroyed by disease or are removed during an operation. Generally the dim outlines of the malleo-incudal joint can be seen through a normal or atrophied drum-head, and occasionally the chorda tympani nerve and other structures.

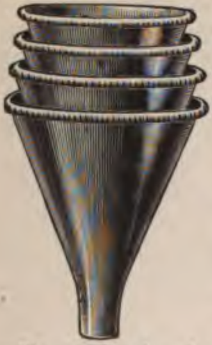
Fig. 21.—Boucheron's specula.

Otoscopic Reflector.—The reflector generally used to illuminate the auditory canal and its fundus is the same as that employed in laryngoscopy and rhinoscopy (see Fig. 2).

The **specula used in otoscopy** are funnel-shaped instruments constructed of hard rubber or metal. Different forms are sold under the names of Wild's, Gruber's, Toynbee's, Boucheron's (Fig. 21), Kramer's, and Politzer's specula. Gruber's specula are probably the best for ordinary purposes of otoscopy because a transverse section of their caliber at right angles to their long axes more nearly corresponds with a similar section of the external auditory meatus. However, Boucheron's specula (Fig. 21) are better adapted for use during an operation upon the middle ear, and with many otologists are favorite specula for purposes of inspection and treatment, because their wide proximal rims afford greater space for the manipulation of instruments, and a firmer grasp to the thumb and fingers when the instrument is held within the auditory canal. Ear specula are usually sold in "nests" of three or four sizes fitting into a case. Those constructed of hard rubber are easily broken, and those manufactured of German silver and nickel plated are necessarily thicker than is desirable; a thin, solid silver speculum, aside from its expensiveness, being the preferable instrument.

Relative Positions of Patient and Observer in Otoscopy. —The patient and observer may both stand in front of a window or the source of artificial light, or both may be seated upon chairs or piano stools so adjusted that the eye of the observer and the ear of the patient are in the same horizontal plane. The ear to be examined should be toward the observer, and the patient's face turned somewhat away from him, because the auditory canal generally extends in a direction inward, forward, and somewhat downward. If the reflector is worn upon the forehead, the source of light should be above or to one side of the patient's head, and so placed as to throw the auricle into the shadow.

To **introduce the speculum** the observer should first direct the light from the reflector upon the orifice of the meatus, and then straighten the auditory canal by gently drawing the auricle upward, backward, and slightly outward, at the same time endeavoring to see the drum-head without the use of a speculum. In many instances this can be accomplished satisfactorily, and the observer should not be in haste to introduce the speculum, as it may dislodge and push into the field of view a flake of wax or epithelium, which will greatly interfere with a distinct view of the membrana tympani. The auditory canal having been straightened in the manner described and the parts being fully illuminated, the speculum is held by its rim with the thumb and finger and gently introduced with a slight rotary motion into the auditory canal, so that its long axis exactly corresponds with that of the canal. The greatest care should be exercised in introducing the speculum not to use it as a lever in such a manner as to bring its sharp edge in contact with the wall of the canal and cause pain; obstruction to the progress of the speculum being overcome by moving the whole instrument in a direction opposite to that in which the obstruction is felt until the membrana is brought into view, when the speculum may, if necessary, be retained in position by grasping it and the auricle in the manner shown in Fig. 22.

Obstacles to Otoscopy.—The chief obstacle to the beginner is caused by so misdirecting the long axis of the ear speculum that it does not correspond with the long axis of the auditory canal, so that a portion of the auditory canal is brought into view or only a portion of the membrana is seen. Under such circumstances the end of the speculum within the ear should be moved about until a satisfactory view of the drum-head has been obtained. Generally it will be found that the cause of failure has been that the axis of the speculum has been directed too far backward and upward. Another cause of difficulty is excessive sensibility of the auditory canal or swelling of its walls, the result of diffuse inflammation. Sometimes a satisfactory view of its deeper

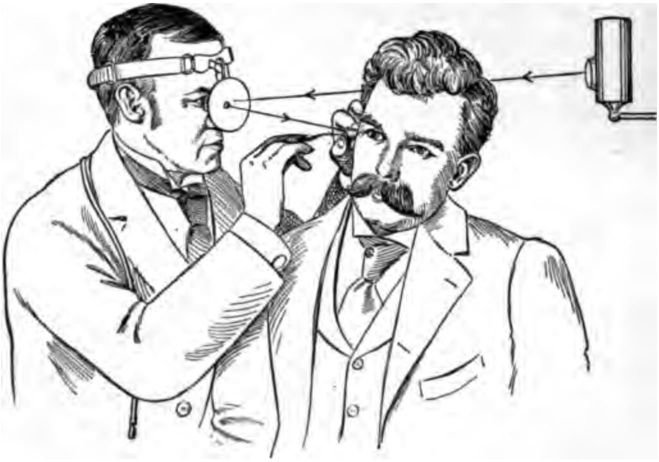

Fig. 22.—Otoscopy with the reflector and ear speculum. The arrows represent course of light.

parts can be obtained under such circumstances by gentle and persistent effort, a small speculum being used to dilate the auditory canal.

Siegle's pneumatic speculum (Fig. 23) is an air-tight chamber to which specula of various sizes can be attached by means of a screw-joint. The side of the air-tight chamber carries a perforated knob, over which is slipped a rubber tube terminating in a rubber bulb. The proximal end of the instrument is glazed either with plane glass or with a convex lens set at an angle of 45 degrees with the long axis of the instrument. When the instrument is in position within the auditory canal, the surgeon is enabled to judge of the mobility of the whole or of a part of the membrana tympani by observing its movements during condensation and rarefaction of the air in the auditory canal brought about by the action of the surgeon's hand upon the rubber bulb. Before using the instrument it is well to slip a short piece of wet rubber tubing over the end of the speculum to ensure its fitting into the auditory canal as nearly air-tight as possible. When the eustachian tube is impervious to air the pneumatic speculum furnishes the only means of determining the mobility of a part or the whole of the membrana tympani.

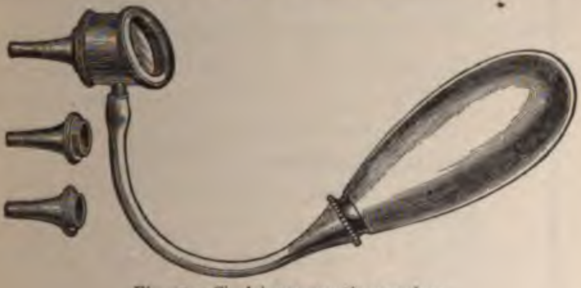

Fig. 23.—Siegle's pneumatic speculum.

Instead of using a rubber bulb to produce rarefaction and condensation of the air in the auditory canal, a *piston-syringe* may be employed or the *masseur of Delstanche.* It should be borne in mind that it is entirely possible to rupture some membrana tympani by too vigorous use of aural massage.

Machines whose motive power is compressed air, electricity, or a water motor are sometimes employed. They yield more rapid rarefaction and condensation of the air of the auditory canal than the hand bulb and occasionally may prove more useful.

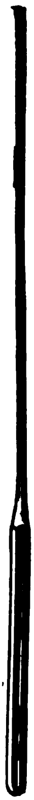

Fig. 24.—Allen's nasal applicator.

ACCESSORY INSTRUMENTS

The **laryngeal sound** consists of a piece of silver wire, rounded at one end and inserted in a universal handle (see Fig. 1). It should be sufficiently long to reach the anterior angle of the glottis without bringing the fingers holding the handle into the patient's mouth, and thus obstructing the view, and sufficiently firm to resist a considerable amount of pressure without bending.

The **cotton applicator** consists of a piece of aluminum or, better, copper or iron wire of about the same size and length as the laryngeal probe, with roughened ends; so that a piece of absorbent cotton can be tightly wrapped around one end without fear of its becoming loose. This tuft of absorbent cotton will carry enough solution for any application within the laryngeal or postnasal cavities. For applications to the nasal cavities smaller instruments are desirable, and Allen's applicator (Fig. 24) is better adapted for this purpose. Allen's probe (Fig. 25) consists of a conic piece of soft, malleable steel wire fitted into an aluminum handle. It is extremely light and delicate and may be used either for the nose or for the ear. When used as a probe, a few fibers of absorbent cotton are wrapped about its tip in order to cover its sharp extremity. The tip of the instrument can be bent into the form of a hook to bring forward nasal polypi or ascertain their place of origin, the thickness of their pedicle, etc., or to probe the attic of the tympanum. The presence of exposed bone is readily detected by the spicules catching in the cotton fibers and imparting a characteristic resistance. It may be used also for the application of chromic acid and other caustics.

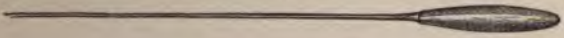

Fig. 25.—Allen's probe.

The Atomizer.—In most forms of throat and nasal disease sprays are extremely useful, not only to cleanse the parts and remove accumulated secretions but also to spread medicated solutions over a large surface. For use in the laryngologist's office and as an atomizer to fit into the rhinologic instrument bag for use in treating patients at their homes the atomizer (Fig. 26) is convenient, as it throws a fine spray either up-

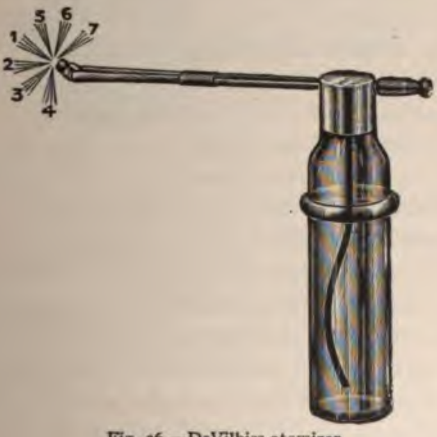

Fig. 26.—DeVilbiss atomizer.

ward, downward, or straight forward. However, for the patient's use at home other types of atomizers are preferable, and the physician should specify by prescription the atomizer that will yield the coarse or fine spray required for the judicious treatment of each case; also he should select for his patient an atomizer that is not readily broken and easily kept in order; or he will have the mortification of discovering that home treatment has been the merest pretence because of the inefficiency of the atomizer. As a general rule, atomizers for patients' use should have a bottle made from thick, strong glass so shaped that it cannot readily be laid on its side. To prevent clogging of long fine tubes the nozzle should be as short as possible, readily cleansed, and made of metal rather than brittle, hard rubber. The hand bulb should be large and made of good quality rubber.

The air-current necessary to produce the spray from atomizers may be supplied either by a rubber hand bulb or an air-compressing apparatus.

In spraying the nose, pharynx, or larynx with a hand atomizer the bottle of the instrument should be grasped between the thumb and first finger of the right hand with the rubber bulb in the hollow of the hand. The rubber bulb can then be pressed by the three remaining fingers with sufficient force and rapidity to give a continuous spray. This method of employing the atomizer leaves the left hand free to elevate the tip of the nose or manipulate a tongue-depressor. In spraying the nasal cavities the tip of the nose should be elevated with the finger and thumb of the left hand, and the end of the atomizer should rest against either the thumb or finger of the operator, and not the rim of the patient's nose. The use of this method will prevent the necessity of sterilizing the end of the atomizer tubes each time they are used upon a patient.

Because secretions tend to gravitate toward the floor of the nose, especial attention should be directed toward the *inferior meatus* in washing out the interior of the nose. The head of the patient is tipped slightly backward and the spray from the atomizer directed somewhat downward, that is, in a direction toward the lobe of the ear. Under such circumstances the nasal secretions that have accumulated on the floor of the nose are readily washed into the pharynx and are hawked down and expectorated. The stream of the atomizer can then be directed to any portion of the upper part of the nose which, on inspection, appears covered by secretions.

However, masses of mucus are more readily removed from the pharynx by means of solid streams of fluid than by the coarsest spray from an atomizer. For this purpose a piston syringe holding about 2 ounces is generally employed. The patient opens his mouth and bends forward over a bowl. The conical nozzle of the syringe is introduced into one nostril and the fluid injected into the nasopharynx, around the septum and out of the other nostril.

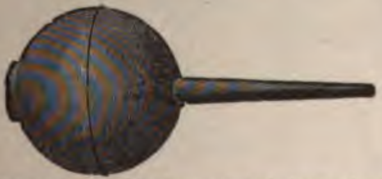

Fig. 27.—Soft-rubber eye, ear, and ulcer syringe.

For the patient's use at home a syringe made of one piece of soft rubber (Fig. 27) answers a useful purpose for syringing the nose or ear. The nozzle of the syringe is made of soft rubber, and hence can be inserted in the auditory canal or nose with little danger or pain.

When an atomizer or syringe is prescribed for a patient's use at home, the object that the surgeon wishes to accomplish should be carefully explained to the patient and he should be instructed in the use of the instrument and how to keep it in good order. If this is not done, the patient's use of the instrument at home will amount to practically nothing. If an atomizer and a detergent spray, such as Dobell's solution, is prescribed with the main object of cleansing the nose, the patient should throw his head back and point the beak of the atomizer downward (not upward), so that the main force of the spray will be directed along the floor of the nose into the nasopharynx. It should be demonstrated to the patient so that he thoroughly understands that if while he is using the atomizer he breathes gently

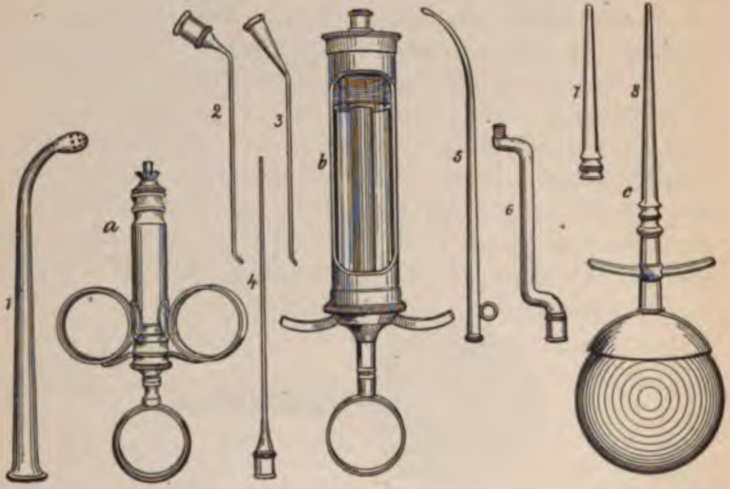

Fig. 28.—Syringes with interchangeable nozzles: *a*, Syringe of ½-dram capacity for cleansing and applying solutions to the attic by means of Blake's cannulas (*2*, *3*, and *4*). Also for making applications to the eustachian tube by means of nozzle 7 and an ordinary eustachian catheter. When fitted with the bayonet tip *6* and a hypodermic needle it may be used for the production of local anesthesia of the ear or tonsil by injections of solutions of cocain and adrenalin. *b*, Syringe, holding 2½ drams, to be used with Blake's cannula for cleansing middle ear or with postnasal nozzle (*1*) for cleansing the posterior nares. It is convenient where the operator prefers a piston- to a bulb-syringe. *c*, Dentists' tooth syringe, capacity 1 ounce. This is probably the best syringe for removing impacted cerumen and for coarse syringing of the auditory canal. When fitted with a moderately large long silver nozzle (*4*) any of the accessory cavities of the nose that can be probed can be washed out through their anatomic orifices. For this purpose the silver nozzle should be made of pure silver, so that it can be bent readily to the requisite curve, and the operator should be provided with four or five such nozzles about 5 inches long and of the diameter of Nos. 3, 5, 6, and 8 of the French catheter scale. Instead of these silver nozzles a eustachian catheter may be employed, or nozzle *5*, fitting on to nozzle *7*, which screws on to the syringe when nozzle *8* is unscrewed. It is well for the operator to be provided not only with several sizes of the straight cannula (*4*), but also with several sizes of Blake's cannulas (*2* and *3*), to be used with syringe *b* or *c*.

through his nose the spray will pass downward behind the relaxed palate into his mouth and can be expectorated. That, on the contrary, if he holds his breath, the fluid will be retained in the nasopharynx upon the contracted palate and will run out of his nose as soon as his head is lowered, with the result that the nasopharynx is not as efficiently cleaned as would otherwise be the case.

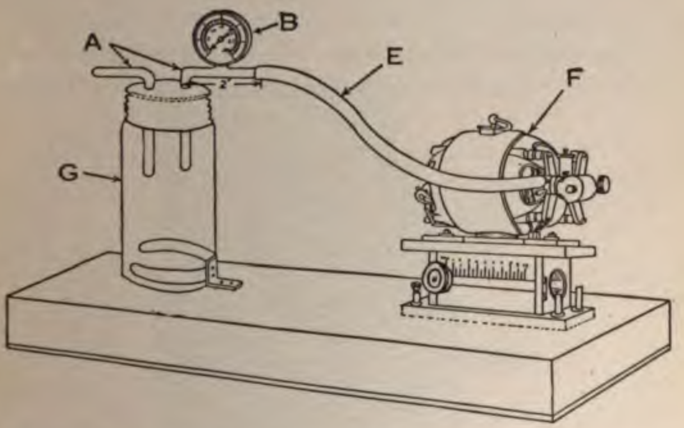

Fig. 29.—MacWhinnie's aspirator for rarefying the air in the nasal accessory cavities: F, Electric motor and pump connected by means of the rubber tubing, E, with the vacuum gauge and regulator, B, and pus bottle, G. The rubber tubing for the nose-piece is attached at A. It and the rubber tube E should be of sufficiently firm material to prevent the tubes collapsing when a vacuum is established. The nose-piece resembles in shape that of a Politzer bag, and several of slightly different sizes and shapes should be at hand. They should be of heavy glass, so that they can be readily cleaned and placed in the sterilizer after being used.

The interior of the *nasal cavities* can be cleansed as thoroughly by means of a hand atomizer as by an atomizer whose spray results from the use of the most expensive of air-compressing apparatus; but the latter are convenient, and where a large number of patients are to be treated save the surgeon's hand the fatigue that would result from long-continued use of the hand atomizer.

There are a large variety of *air compressors* for sale in the instrument stores, and it is difficult to state which one is the most practical and useful. Automatic water pumps with compressed air tanks often render better service than electric pumps.

The *automatic cut-off* is an instrument by which compressed air is conveniently supplied to an atomizer. The end of the instrument is attached to the rubber tubing of the compressed-air apparatus, and the nozzle of the instrument inserted into the hole in the nipple of the atomizer, from which the hand bulb previously has been removed, and by pressing down the lever a current of compressed air is forced through the atomizer in the same manner as if a rubber hand bulb were used. The current of air ceases as soon as the lever is released. In using the automatic cut-off, the atomizer is held in the right hand and the lever of the automatic cut-off pressed downward by the thumb.

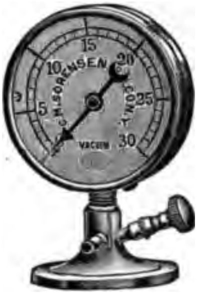

Fig. 30.—Vacuum gauge with regulator, devised for controlling any degree of vacuum, eliminating excessive aspirating of the delicate membranes.

Sinks.—A most convenient adjunct to a laryngologist's office is a sink. It should be supplied with hot and cold water. There have been a number of sinks manufactured for the use of physicians and hospitals. The best are constructed of white porcelain, and the flow from the spigot is controlled by foot levers. This arrangement prevents the necessity of turning off the water with the hands after they are washed.

A *swinging cuspidor* may be attached to the sink or wall in such a manner that it can be swung out of sight when not in use. A water cuspidor such as is employed by dentists is not more convenient, but certainly looks better than even the most ornamental receptacle for expectoration, and although bulky, adds somewhat to the appearance of care and neatness about the office.

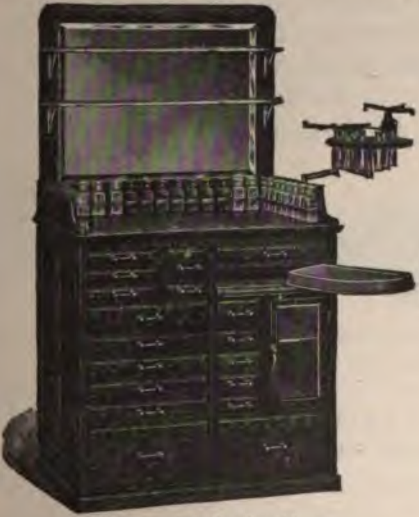

Fig. 31.—Pynchon's cabinet.

Pynchon's cabinet (Fig. 31), for instruments, linen, etc., is a convenient office accessory. It is provided with 18 drawers of different sizes (each partitioned to accommodate regular and special instruments) and compartments for clean and soiled linen.

The **nebulizer** is useful because vapors will penetrate where fluids and the spray from an atomizer will not. These instruments, therefore, may be employed in the treatment of diseases of the middle ear and the accessory cavities of the nose and the smaller bronchial tubes.

Nebulizers are manufactured in many styles, from the single nebulizer, for patients' use at home, to more elaborate instruments for office use, which consists of a number of nebulizers connected together in such a manner that one or more can be utilized at a time.

Inhalers are employed for the inhalation of the vapors of a drug suspended in hot water. The simplest form of this instrument is the bottle-inhaler. It consists of a wide-mouthed bottle, through the cork of which two glass tubes are thrust. One reaches nearly to the bottom of the bottle; the other passes simply through the cork, and is bent at the upper extremity. The bottle is filled one-third full of a solution, and the patient, by inhaling through the bent glass tube, causes air to bubble through the fluid and become impregnated with the volatile substances in the fluid before being drawn into the lungs. Compound tincture of benzoin (1 teaspoonful to the inhaling bottle one-third full of hot water) is a domestic remedy of considerable reputation and some value in inflammation of the upper respiratory tract.

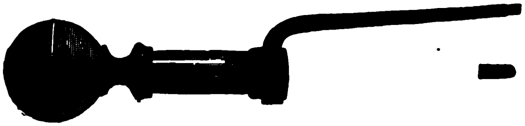

Fig. 32.—Davidson's reservoir powder-blower. The instrument is also made with a curved tip.

The Powder-blower.—Remedies are often applied to the interior of the nose and larynx in the form of an impalpable powder. For this purpose the instruments shown in Figs. 32

and 33 will be found useful. The reservoir insufflators of Davidson and similar instruments are very convenient and obviate the necessity of loading the powder-blower each time that it is used. However, they have the disadvantage of sometimes becoming temporarily clogged, and at the next attempt to use them discharge a much larger quantity of powder than is required. A very large amount of powder might be unexpectedly thrown into a patient's larynx from this instrument, causing momentarily great distress and severe laryngeal spasm. However, the spasm quickly subsides if the patient is given a glass of water to drink and told to hold his breath for a moment. Such accidents can, however, be avoided by not using a reservoir powder-blower for laryngeal work.

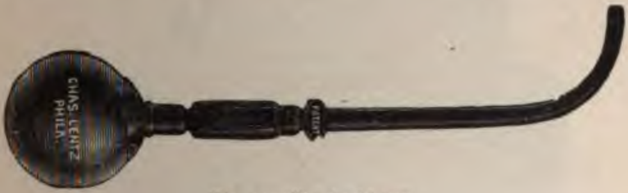

Fig. 33.—Powder-blower.

The Hot-air Apparatus.—Hot air is occasionally beneficial in the treatment of diseases of the upper respiratory tract and middle ear. It allays the swelling and irritation and decreases blood-pressure. It is useful in acute inflammatory diseases of the accessory sinuses and middle ear, although the relief is often transient.

STERILIZATION OF INSTRUMENTS

All instruments used in operations upon the nose, throat, or ear should be carefully sterilized by boiling in a 5 per cent. bicarbonate of sodium solution. After an operation the instruments are placed in a tray and soaked for five minutes in cold water to dissolve the dried blood adhering to them.

They are then scrubbed with hot water and soap. If they need polishing, sapolio or a fine sand-soap should be used. They are then boiled for five minutes in a 5 per cent. solution of sodium bicarbonate and rapidly dried while still hot in order to prevent rusting.

For the rapid drying of larger instruments, wiping with a sterile towel while the instruments are still hot answers every purpose. For smaller instruments and those with delicate joints—cannula, snares, etc.—it is better after boiling to wipe them with a towel and then immerse them in 95 per cent. alcohol for a minute or two. They should then be carefully wiped with a towel, so that every particle of moisture is removed by the wiping and the evaporation of the alcohol.

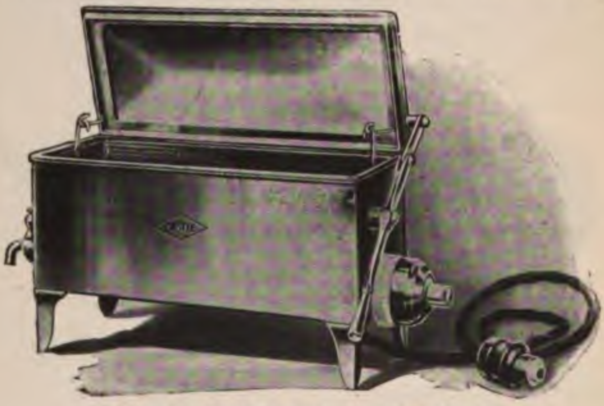

Fig. 34.—Castle-Rochester electric sterilizer.

Instruments for examination and treatment, such as tongue-depressors, specula, probes, applicators, etc., used so frequently during the office hours or in dispensary work that, unless the surgeon possesses a large stock of these articles that can be boiled at the beginning of the hour in sufficient numbers to furnish each patient a special instrument without exhausting the supply, are best sterilized by burning with wood alcohol. This method has the advantage that it takes but a moment and can be done in the presence of the patient, who is thus assured beyond peradventure that only sterile instruments have been used in the diagnosis and treatment of his case.

The operator should be provided with two white enameled steel trays. In the first of these should be placed instruments for the examination and treatment of a patient. Over the instruments should be distributed a teaspoonful or two of wood alcohol, which is then lighted with a match. The flame lasts but for a moment, but the instruments are heated far above the temperature of boiling water, and are, of course, rendered absolutely sterile.

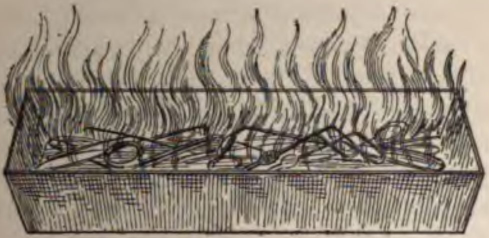

Fig. 35.—Sterilizing instruments by flaming with alcohol.

Small instruments treated in this manner cool almost as rapidly as they are heated. Larger instruments, like tongue-depressors, retain their heat for an inconvenient time, and it may be necessary to cool them by dipping them in water, spraying them with an atomizer containing an alkaline wash, or pouring a little grain alcohol over them. As the instruments are used they are placed in the second tray, and are sterilized in the same manner before being again employed.

The disadvantages of the method are that it cannot be used for small aluminum instruments or those soldered with soft solder and that it soon tarnishes the instruments.

Syringes, soft-rubber tubes, hard-rubber nozzles, and glass

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instruments are best sterilized by soaking them for five or ten minutes in a 5 per cent. aqueous solution of formalin (40-volume aqueous solution of formaldehyd gas). The barrel of the syringe should be filled with the solution and the entire syringe immersed. If the syringe is sterilized in this manner immediately before being required it should be carefully rinsed in sterile water before being used to prevent the irritating effects of formalin, for it should be borne in mind that even very dilute solutions of formaldehyd gas are very irritating to the mucous membranes of the nose, throat, or middle ear.

Atomizers should be used in the manner previously described, so that the tips never come into actual contact with the patient on whom they are used. When made with interchangeable tips the extra tips may, of course, be kept in an antiseptic solution, that of formaldehyd being perhaps the most reliable.

Although boiling in sodium bicarbonate solution and the other methods of disinfection described above are reliable, it is advisable for psychologic reasons at least to have a special set of instruments for syphilitics and another special set for those with tuberculosis.

Preparation of Operator.—Before operating on the nose or throat the surgeon should prepare himself, as for any other operation, by scrubbing his hands and arms with green soap, rinsing in alcohol, and immersing his hands in bichlorid solution, or prepare himself by any other method he has found satisfactory.

Sterilization of Nose.—Unfortunately we do not possess a reliable antiseptic for sterilizing the nose or nasopharynx. Any solution of carbolic acid (probably the most sedative to mucous membranes of the common antiseptics) strong enough to kill bacteria would excite a local inflammation that would interfere greatly with the rapid healing of the operative wound, and invite infection instead of prevent it. The same remark applies in still greater degree to other antiseptics. However, before an operation the mucous membrane should be freed, especially in atrophic cases, from adherent mucus by syringing with an alkaline or normal salt solution.

EXAMINATION OF PATIENTS

First listen passively to the patient's story of his illness; asking judicious but not leading questions, so as to elicit the facts of the case, such as the influence of his employment upon his health, or any inherited tendency that he may have toward disease of the nose, throat, or ears, cause of the disease, the length of time that it has continued, and the symptoms other than disease of the nose, throat, or ears that may be present. In questioning the patient the physician should bear in mind the effects of "suggestions" upon patients of nervous temperament as regards tinnitus. Many neurotics with disease of the middle ear will experience for the first time subjective noises in their ears upon being asked leading questions in regard to tinnitus, and afterward complain of the presence of this symptom, which previous to that time had not attracted their attention.

Careful notes of the patient's history should be made in the case-book, and especial prominence be given to the symptoms of the disease from which he seeks relief.

Examine the **tongue,** as to whether coated or clean, pale or flabby, or of a natural color and resistance; look for ulcerations or mucous patches upon the tongue or the inside of the mouth; and also notice the number, shape, and condition of the teeth. Having depressed the tongue, observe the palate and uvula, the anterior pillars and tonsils, the posterior pillars and posterior pharyngeal wall. Notice any change from the natural color, shape, or mobility of the parts, the presence or absence of foreign bodies or hardened secretions.

The **nose** should next be examined by anterior and posterior rhinoscopy and, finally, the laryngeal mirror should be introduced. In these examinations notice the condition of

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After the hearing has been tested, the aurist should inspect the parts of the **ears** made visible by means of otoscopy, carefully noting the condition of the external auditory canal and drum-head; and if the membrane be wholly or partly destroyed as the result of disease or accident, noting the condition of the mucous membrane of the tympanum and other structures that may be visible. In most instances it is advisable to make a diagram or rude drawing of the condition of the tympanum, and in making notes as to the result of otoscopy to give to each ear one or more separate lines in the note-book in the same manner as when recording the results of the tests for hearing.

The patency of the **eustachian tubes** should next be tested by means of the Politzer method and the aural stethoscope or, if necessary, the eustachian catheter should be used.

In suitable cases the patient's equilibrium should now be examined and the functional reaction of the labyrinths to turning, caloric, and galvanic tests.

THE NOSE

ANATOMY OF THE NOSE

THE **external nose** is an arch-shaped framework, bony above and cartilaginous below, covered by integument externally and lined within by mucous membrane. It is separated into two portions, practically two noses, by the *nasal septum*.

The **bony arch** or bridge of the nose (Fig. 37) is composed of the nasal processes of the superior maxillary and the nasal bones.

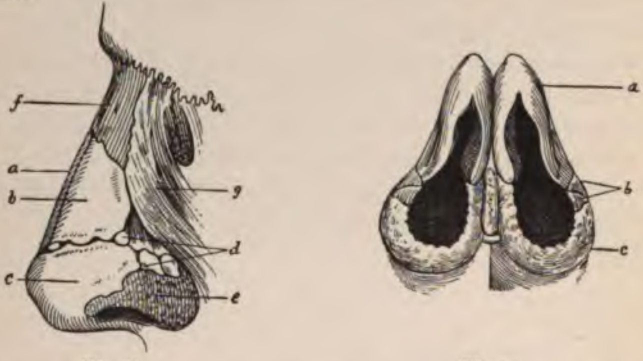

Fig. 36.

Fig. 37.

Figs. 36 and 37.—Bones and cartilages of the external nose. Fig. 36, Side view: *a*, Cartilage of septum; *b*, upper and (*c*) lower lateral cartilages; *d*, sesamoid cartilages; *e*, cellular tissue; *f*, nasal bone; *g*, nasal process of superior maxillary bone. Fig. 37, View from below; *a*, Lower lateral cartilage; *b*, sesamoid cartilages; *c*, cellular tissue.

The **cartilaginous arch** consists of the upper and lower lateral cartilages and the *sesamoid cartilage*, usually three on each side of the nose. The cartilages are bound together by strong connective tissue, and by the action of muscles upon them the opening into the nose can be dilated or narrowed.

The *alæ* or wings of the nose contain no cartilage, but consist of a mass of cellular tissue and fat.

The *nasal septum* consists of bone and cartilage covered by mucous membrane. Its cartilaginous portion is the so-called *triangular cartilage*, because it fits into a triangular space between the perpendicular plate of the ethmoid and the vomer (Fig. 38). However, the cartilage of the septum is quadrilateral in shape. The perpendicular plate of the ethmoid and the vomer, the nasal crests of the superior maxillary, palate, and nasal bones, and the nasal spines of the frontal and maxillary, enter into the formation of the septum. It is developed from a bilobed mass, the mesial nasal process; and when its lower portion ossifies to form the vomer this bilateral character is preserved to the extent that a deep groove is formed along the upper border of the

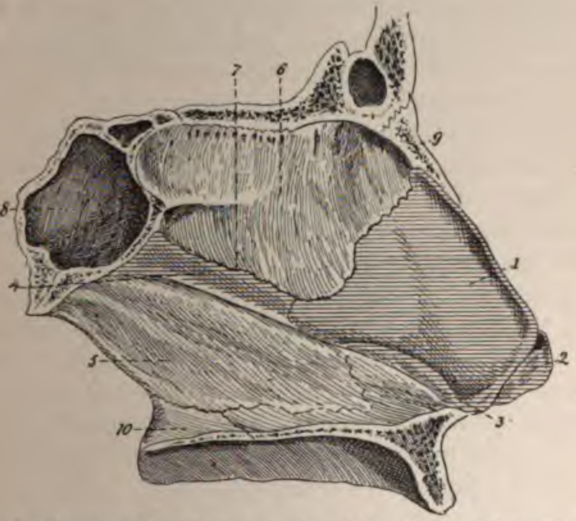

Fig. 38.—Osseous and cartilaginous septum of the nose: *1*, Triangular cartilage of the septum; *2*, median plate of the lower lateral cartilage, sometimes called columnar cartilage and cartilage of the aperture; *3*, cartilage of Jacobson; *4*, supravomerine cartilage sometimes present; *5*, vomer; *6*, perpendicular plate of ethmoid; *7*, ethmovomerine suture; *8*, sphenoidal sinus; *9*, nasal bone; *10*, palate bone (Arnold).

vomer between the plates. In this groove there is a strip of cartilage which frequently persists during the entire adult life and is called the *vomerine* or *supravomerine* cartilage. The groove, sometimes distorted into an imperfect tube or into other shapes, is called the *vomerine crest.* Ridges of bone and cartilage extending obliquely upward along this crest are the result of the distortion or overgrowth of the vomerine crest or cartilage. The nasal septum is covered by mucous membrane, beneath which, near the nasal floor, is ill-developed erectile tissue. Specialized nerve-filaments of the sense of smell occupy a small area in the mucous membrane of the upper portion.

The *skin* covering the external nose, especially at the tip, is rich in sebaceous glands; when diseased the contents form comedones. At the tip of the nose beneath the skin is a cushion of fat which when hypertrophied aids in the production of "pug nose." The skin extends into the nose nearly to the anterior extremities of the inferior turbinated bones, and at the entrance into the nares it is usually covered with short thick hairs, the vibrissæ.

The *muscles* of the external nose are the levator alæ nasi, depressor alæ nasi, levator alæ nasi props, and the musculis apicis. These muscles by their action dilate and make narrow the anterior nares during respiration.

The *arteries* of the external nose are the lateralis nasi, a branch of the facial, nasal branches of the ophthalmic and infra-orbital, and the septal artery from the superior coronary artery.

The *nerves* of the external nose are branches from the facial, infra-orbital, infratrochlear, and the nasal branch of the ophthalmic.

The **nasal cavities** are the commencement of the upper respiratory tract. They extend from the anterior nares to the posterior wall of the pharynx, and consist of two chambers, divided from each other by the septum. The floor is separated from the roof of the mouth by comparatively thin structures and hence is parallel to it. The roof is formed by the nasal bones and nasal spines of the frontal bone, the horizontal plate of the ethmoid, and the anterior wall of the sphenoidal cells. The lateral walls are formed by portions of the frontal, lacrimal, ethmoid, sphenoid, and superior maxillary bones.

Upon the lateral walls of the nasal chambers are the superior, middle, and inferior turbinated bones (Fig. 40). The *inferior turbinate* is a separate bone, but the *superior* and *middle turbinates* are portions of the ethmoid. At birth this portion of the ethmoid is often divided into three or even four turbinated bones by grooves that disappear later in life. The *agger nasi* is a slight elevation at the junction of the anterior end of the middle turbinate with the superior maxillary and is the rudiment of the nasal turbinate of the lower animals. Beneath the turbinated bodies are their respective meati: the superior, middle, and inferior meati. The *inferior meatus* extends backward and downward, and at the junction of its anterior third with the posterior two-thirds receives from beneath the inferior turbinated body the secre-

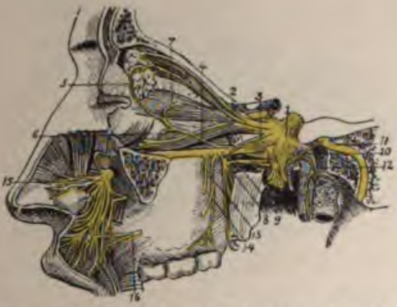

Fig. 39.—Superior maxillary nerve and some of the orbital nerves: *1*, Gasserian ganglion; *2*, lacrimal nerve; *3*, trunk of superior maxillary nerve; *4*, its orbital branch; *6*, origin of its malar twig; *7*, its temporal twig, joined by *5*, communicating branch from lacrimal nerve; *8*, sphenopalatine ganglion; *9*, vidian nerve; *10*, its upper branch or great superficial petrosal nerve proceeding to join *11*, facial nerve; *12*, its lower branch or great deep petrosal nerve joining sympathetic; *13*, *14*, posterior dental nerves; *15*, terminal branches of infra-orbital nerve in the face; *16*, a branch of facial uniting with some of the twigs of infra-orbital.

tions of the eye through the nasal duct (Fig. 62). Its position upon the floor of the nose renders the inferior meatus the important drainage fossa of the nose, and along it the spray of an atomizer or the stream of a syringe should be directed if it is desired to wash secretions into the pharynx. Above the inferior turbinated body is the *middle meatus*, and because of the numerous ostea opening into it is an important fossa in nasal diseases. The superior turbinated body is a portion of the ethmoid separated from the middle turbinate by a groove, the *superior meatus*, closed in front, but opening posteriorly into the spheno-ethmoidal recess.

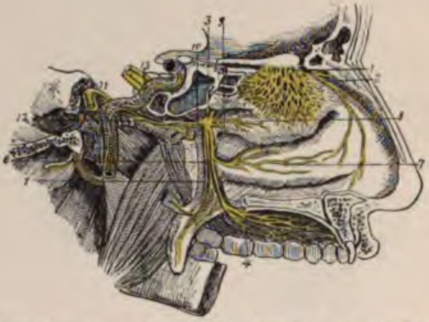

Fig. 40.—Nerves of nose and sphenopalatine ganglion, from inner side: *1*, Network of external branches of olfactory nerve; *2*, nasal nerve, giving its external branch to outer wall of nose; the septal branch is cut short; *3*, sphenopalatine ganglion; *4*, ramification of large palatine nerve; *5*, small, and *6*, external palatine nerve; *7*, inferior nasal branch; *8*, superior nasal branch; *9*, nasopalatine nerve cut short; *10*, vidian nerve; *11*, great superficial petrosal nerve; *12*, great deep petrosal nerve; *13*, the sympathetic nerves ascending on internal carotid artery.

The nasal cavities are divided into vestibular, respiratory, and olfactory regions, and the accessory sinuses.

The *vestibular region* is all that portion of the nose anterior to the turbinated bodies. The *respiratory region* is the inferior nasal chambers posterior to the vestibular region, bounded above by the inferior edge of the middle turbinated body. Through this region of the nose the respiratory air-currents *arch* on their way to and from the pharynx. The *olfactory region* lies above the inferior edge of the middle turbinated body, and the space between the middle turbinate and the septum is the olfactory slit.

At birth the hard palate is on a level with the junction of the sphenoid and basilar process; at three years it is opposite the middle of the basilar process, and at six years, as in the adult, opposite the anterior edge of the foramen magnum.

The **mucous** or **schneiderian membrane** of the nose is a continuation of the external tegument, and is continuous with that of the pharynx, the eustachian tubes, and the accessory sinuses. It is sometimes called the *pituitary* (meaning phlegm-producing) *membrane* or the *schneiderian*, after Schneider, an anatomist, who first proved that the nasal secretions were produced by it and not by the brain. In many portions of the nose it is thin and inseparable as a membrane from the periosteum or perichondrium beneath, but over the inferior turbinate and the adjacent portion of the septum, as well as the inferior edge of the middle turbinate, it is thick and vascular. In these regions is the so-called *erectile tissue*, somewhat similar to that of the sexual organs, consisting of cavernous blood-vessels embedded in cellular tissue. When this tissue erects itself, that is, when its vessels fill with blood, the bulk of the nasal membrane enormously increases and may cause almost complete stenosis of the nasal chambers.

The vestibular mucous membrane is covered by stratified pavement epithelium and contains sweat and sebaceous glands, and anteriorly vibrissæ or short hairs that serve to prevent the entrance into the nostrils of coarse particles of dust and insects. The mucous membrane of the respiratory region is covered by pseudostratified ciliated epithelium and contains goblet-cells. Mucous, serous, and lymphatic glands are numerous. The mucous membrane of the olfactory region contains no erectile tissue and to it are distributed the specialized nerve-endings of the olfactory nerve. It is covered by a single layer of cylindric epithelium and contrasts by its yellow color with the bright pink of the parts below. In this thin pale membrane are the olfactory and sustentacular cells capable of receiving sensory impulses recognized as odors.

The **arteries of the nasal fossæ** are the anterior and posterior ethmoidal from the ophthalmic, the sphenopalatine branch of the internal maxillary, and the alveolar branch of the internal maxillary to the antrum.

The **nerves of the nasal fossæ** (Fig. 40) are the nasal branch of the ophthalmic to the septum and outer wall, anterior branch of the superior maxillary to the inferior turbinated body, and the floor of the nose. The sphenopalatine ganglion gives off the vidian nerve to the septum and superior turbinated body and the superior nasal branch to the same regions, the nasopalatine to the middle of the septum, and the anterior palatine to the middle and lower turbinates.

The nerve-cells of Meckel's ganglion possess no spontaneity of action of their own, but are wholly dependent for their excitation upon nerve impulses of the central nervous system. They may be excited to activity or inhibited either by the arrival of impulses transmitted from the surface of the nasal mucosa by the nasal and other branches of the trigeminal nerve and from the skin by the cutaneous nerves, or by the arrival of impulses descending from the cerebrum in consequence of psychic states. Whether the excitation is reflex or direct the resulting change in secretion and vascularity will be proportional to the intensity of the peripheral or the cerebral excitation.

The olfactory or first cranial nerves from the olfactory bulb enter the nose through twelve or more openings in each side of the cribriform plate. They are distributed to the specialized nerve-endings in the mucous membrane of the superior turbinate and a corresponding small region of the septum.

The **lymphatics of the nose** are numerous. The more anterior terminate in the submaxillary glands, the posterior communicate with the pharyngeal glands. Hence the not uncommon slight inflammation of the tonsils and cervical lymphatics after nasal operations.

PHYSIOLOGY AND PATHOLOGY OF MUCOUS MEMBRANES

During respiration through a normal nose the bulk of the air passes along the septum above the inferior turbinated body, describing a semicircle in its course, smaller currents extending upward nearly to the roof of the nose. However, a considerable volume of air passes through the inferior meatus, eddying downward from the main current above the inferior turbinate and circling backward along the inferior meatus. The direction of the breath current is largely due to the horizontal position of the anterior nares, and because of the vertical position of the posterior nares the expiratory current is by no means as complicated as the inspiratory. It simply spreads out like a fan in its passage through the nose and, hence, a larger volume of air passes through the olfactory region during expiration than inspiration, a fact that doubtless has an important bearing on the appreciation of the flavor and odor of foods during mastication and swallowing. It is understood, of course, that the respiratory path changes with the shape of the nasal chambers. Abnormal dryness of the nasal mucous membrane, or nasal obstructions of a kind to interfere with the free access of air to the olfactory portion of the nose, interfere greatly with the acuteness of the sense of smell.

The nose also serves as a resonant cavity during vocalizations, so that obstruction of the nasal chambers produces a peculiar nasal intonation during speech. Perhaps the most important function of the nose is to warm, moisten, and free from the dust inspired air. In health exhaled air has a temperature of 98.5° F., and it has been proved experimentally that most of the heat supplied to inhaled air comes from the nose, the turbinated bodies being well adapted not only to warm the inspired air, but to moisten it and free it from particles of dust which adhere to its moist, sticky surface.

Dust particles removed from the skin of the face and from the vibrissæ contain numerous bacteria from which cultures can be made. On the other hand, bacteria removed from the surface of the normal nasal mucous membrane evince little vitality and cultures are made from them with considerable difficulty. Hence it has been claimed that the nasal secretions possess sufficient antiseptic qualities to destroy some bacteria and inhibit the growth of others. The practical point from this is that irritating antiseptic sprays before an operation are uncalled for, and by setting up what might be called a *chemic rhinitis* tend to promote the growth of bacteria rather than destroy them. This is particularly true of solutions of corrosive sublimate. However, meningococci are said to grow more rapidly in culture-media to which diluted nasal mucus is added.

In inflammation of mucous membranes the secretions are either increased or decreased in quantity, so as to either flood the parts or leave them unnaturally dry. It should be borne in mind that the normal secretion of the nasal mucous membrane is over 16 ounces of clear watery mucus in twenty-four hours, a part of which in health passes unnoticed through the nasopharynx down into the esophagus and stomach, Only when by obstruction or irritation, due to any cause whatever, this easy outflow and abundant secretion is interfered with, do we perceive a thickening and an accumulation of mucus, which is composed largely of epithelial cells in a state of fatty degeneration, mucous corpuscles, and the impurities from the inspired air. When mixed with pus or blood the secretions become yellow, green, or brown in color; and if retained upon the mucous membrane for a sufficient length of time the secretions become offensive as the result of putrefactive changes.

"Catching cold" is the result of a transient influence upon the vasomotor system of nerves, producing an uneven distribution of blood in the capillaries, especially manifesting itself as a congestion of the mucous membrane of the upper respiratory tract, followed in most instances by inflammation, swelling, and excessive secretion, which then becomes infected by bacteria. It is probable that the phenomena of "catching cold" is largely of a reflex nature in which the peripheral sensory nerve fibrillæ of the skin and extremities perceive the abstraction of heat as a shock, and being afferent in their conductive function, convey the impression to their respective ganglia, whence it is reflected by means of the efferent vasomotor fasciculi to the vessels, causing their dilatation and congestion, and, finally, inflammation of the structures containing them. This theory not only explains the ordinary phenomena of a "cold in the head," but also the pain of neuralgia and rheumatism suddenly produced by "catching cold." Dilatation of the vasonervorum, resulting perhaps in the effusion of serum, produces pressure upon a nerve within its sheath and consequent pain in the muscle or skin containing it.

The reason why the mucous membrane of the upper air-passages is the most frequent seat of an inflammation due to cold or a chilling of the surface of the body is that the sudden change of temperature produces, in the first place, an effect upon the sensory nerve-fibers in the skin, which impression is communicated to the vasomotor centers, and consequently results secondarily in a contraction of the blood-vessels of that portion of the skin which has been affected with a corresponding dilatation at some portion of the vascular system least able to resist the pressure. Inasmuch as our variable climate, the impurities of the atmosphere, and our artificial way of living have a tendency to weaken the capillaries of the upper air-passages from early childhood, that portion of the human economy is, therefore, the region most liable to suffer from this unequal distribution of blood. There results, first, engorgement of the parts, increased secretion, and, finally, inflammation.

However, frequently recurrent coryza is often only one of the manifestations of the sluggish elimination of waste products and toxins which when excreted through the nose cause irritation and swelling of its mucous membrane. In certain individuals an error in diet is promptly followed by an attack of coryza. Under such circumstances local treatment should be supplemented by a carefully ordered diet and, more important still, salines in sufficient quantities to secure daily copious evacuations.

INFLAMMATION OF MUCOUS MEMBRANES

The most common forms are acute and chronic catarrhal inflammation, purulent, croupous, and diphtheritic inflammation.

In **acute catarrhal inflammation** an increased blood-supply stimulates the epithelial layer of the mucous membrane to increased activity; new cells are rapidly formed and cast off, while the glands pour out their secretion in excessive quantities and an abundant liquor sanguinis transudes the vessels, the mucous membrane at the same time appearing red and swollen.

Chronic catarrhal inflammation differs from acute catarrhal inflammation in that the subepithelial layer of the mucous membrane is more involved. Connective tissue is developed by a slow process of proliferation. Usually the mucous membrane is thickened and hypertrophied, and there occurs increased activity in the lymphoid cells, finally producing hypertrophy of the tonsils or other adenoid structures. Activity of morbid processes, confined largely to epithelial and lymphoid structures, belongs essentially to the younger period of life; while morbid activity in the connective-tissue structures belongs essentially to later life, rendering it much more difficult to bring about a cure in the catarrh of an adult than in that of a child.

Croupous inflammation is of a higher grade than catarrhal; for, while it commences in the same manner, with increased blood-supply, rapid cell growth and proliferation, increased secretion, and a throwing off of immature cells, leukocytes, and liquor sanguinis, it differs from it in the fact that the exudate contains a large amount of fibrin and albumin, which coagulate upon the surface of the mucous membrane, forming a false membrane. This false membrane is at times so soft and almost granular in character as to be easily removed with a soft brush. At other times it is tougher and difficult of removal; but in either case, when removed, the mucous membrane is left intact or only deprived of some superficial epithelial cells.

Diphtheritic inflammation is also characterized by the formation of a false membrane, but its pseudomembrane permeates the mucous membrane so densely that it can only be removed by bringing away with it the entire thickness of the mucous membrane to which it is attached, thus leaving the parts below completely denuded. A diphtheritic pseudomembrane is of a dark grayish color, resembling somewhat an ordinary slough of the mucous membrane, in contradistinction from a croupous membrane, which is of a bluish-pearl color, with no appearance as of sloughing of the parts.

DISEASES OF THE NOSE

Effect of Diseases of the Nasal Passages on Other Parts of the Body.—Nasal disease may extend to the pharynx, ear, or larynx by continuity of structure, or affect the other respiratory organs by abeyance of the functions of warming, moistening, and filtering the inspired air, so that it enters the pharynx cold, dry, and dust-laden. Chronic pharyngitis and laryngitis frequently result from this cause; and while it is not easy to prove that pneumonic phthisis is indirectly the result of atrophic rhinitis, yet it is difficult not to suspect some such relationship. As the result of nasal disease there are often induced certain reflex phenomena, viz., nasal cough, nasal asthma, nasal vertigo, nasal epilepsy, nasal chorea, hay-fever, pareses of the palate and larynx, neuralgia and headache, reflex skin rashes, affections of the eye, both inflammatory and muscular; amblyopia, suppuration of the orbit, and meningitis by infection from suppurating accessory nasal sinuses.

The reflexes which originate in nasal or nasopharyngeal irritation and terminate in cough, laryngeal spasm, or asthma, follow much the same pathway as the reflex known as sneezing. The nasal branches of the ophthalmic division of the fifth nerve and the nasal branches of the anterior palatine descending from Meckel's ganglion, which is in connection with the superior maxillary division of the fifth nerve, conduct the sensory impressions to the medulla. It is there reflected to the respiratory, pneumogastric, and other centers; whence the deep inspiration, the forced expiration, and the coincident spasm of the pharyngeal and laryngeal muscles, termed "a sneeze."

Acute rhinitis is an acute catarrhal inflammation of the nasal mucous membrane.

Etiology.—It is generally the result of exposure to cold and wet when the body is overheated. It may, however, be produced by breathing hot dry air or inhaling irritating vapors and dust, errors of diet, or come on apparently as the result of a venereal debauch. Chronic catarrh, syphilis, rheumatism, dyspepsia, or a debilitated state of the system renders an individual more liable to attack. The bacteria most commonly found in the discharges are: (1) Bacillus influenzæ; (2) B. leptus; (3) Friedländer's bacillus; (4) Micrococcus catarrhalis; (5) M. paratetragenus. The more chronic form of the disease has practically always the Friedländer's bacillus in its discharges. On the other hand, Rossbach observed that in rabbits, when the trachea was opened and ice applied to the abdomen, after a short period of pallor, the mucous membrane reddened and finally took on the dusky hue resulting from venous congestion. These appearances he attributed to the reflex from the skin acting on the vasomotor system in such a manner as to first produce contraction, then dilatation, and finally paralysis of the vessels of the mucous membrane with altered secretions and other symptoms of inflammation. He believes that only after the resistance of the mucous membrane is thus decreased do bacteria find a suitable culture-media in the altered secretions; and hence *are not the initial cause of the inflammation.*

Pathology.—At first the mucous membrane, though swollen and congested, is dry. As the disease progresses, there is an abundant serous discharge, which becomes more and more charged with broken-down epithelial cells, lymph-corpuscles, pus-globules, etc., until the discharge assumes the character of thick tenacious mucus or mucopus. The deeper lying tissues also participate in the process. The erectile tissue becomes gorged with blood and swollen, in some instances completely occluding the nares.

Symptoms.—The onset may be simply an attack of sneezing, followed by increased and thickened discharges. In other cases the attack begins with chilly sensations and a general feeling of illness. There is a sensation of fulness and pain about the nose and forehead. The face may be flushed, the eyes suffused, and fever be present. Sensations, suffocating in character, may be present from occlusion of the nares, and the dicsharges be so irritating as to scald the skin of the alæ and upper lip. A cold in the head lasts from two or three days to as many weeks. It generally ends in complete resolution, but frequently repeated, is a common source of chronic nasal catarrh. In nursing children the child takes nourishment only with difficulty, frequently pausing to breathe through the mouth.

Treatment.—A cold in the head can often be aborted at its commencement by a hot bath and a bowl of hot lemonade at bedtime, with or without 10 gr. of Dover's powder, followed in the morning by a saline purge and the wearing of extra warm clothing. The turgescence of the nasal mucous membranes and discharges can always be abated by the application of a 2 per cent. solution of cocain. This effect of the cocain can be kept up for several hours by spraying the interior of the nose with a 2 per cent. solution of antipyrin immediately after the application of the cocain solution. If repeated every day this treatment gives great and immediate comfort to the patient and cuts short the course of the disease, while a soothing snuff (Formula 114), used by the patient in the intervals between the applications, adds much to the efficiency of the treatment. In severe cases the patient had better remain in bed, and the presence of fever requires the administration of aconite in small doses at frequent intervals. Many pill makers manufacture what they term "rhinitis tablets," the active ingredient of which is atropin; gr. $\frac{1}{120}$ of this drug, taken every two hours for four or five doses or until a sensation of dryness in the throat is produced, and then at much longer intervals, yields decided relief in controlling the nasal symptoms, but in some individuals produces headache, a hot dry skin and throat, and general discomfort. Autogenous vaccines sometimes do good, but the promiscuous administration of stock vaccines as a prophylactic against colds is not in accord with the scientific treatment of disease.

Simple chronic rhinitis, turgescent rhinitis, is a catarrhal inflammation of the nasal mucous membrane, exhibiting but a slight tendency to spontaneous recovery. Turgescent rhinitis is a recurrent swelling or turgescence of the erectile tissue at irregular intervals, mostly at night. The parts may appear nearly normal between attacks.

Etiology.—It is generally the result of uncured rhinitis or frequent attacks of coryza.

Pathology.—The mucous membrane of the nose presents precisely the appearance seen in acute rhinitis, only it is less swollen and less red in color. The discharge is either watery, if the upper parts of the nose, especially the mucous membrane of the middle turbinated bodies are the parts most affected, or it approaches mucopus in character if the disease is mostly located in the lower parts of the nose.

The *symptoms* are precisely those of acute rhinitis, only less pronounced. There is a feeling of fulness about the nose. There is alternating stenosis as the result of turgescence of first one nasal chamber and then the other, a continual discharge, and the sufferer is continually "catching cold," when, of course, all his symptoms are increased in severity.

Prognosis.—Untreated, chronic rhinitis may continue indefinitely, and finally result in hypertrophic rhinitis, the pharynx also gradually becoming affected. Under treatment a cure is frequently brought about in from three to six weeks.

Treatment.—Ordinarily the tone of the system is below par and a tonic is indicated. In such cases Formula 134 answers a useful purpose. If the bowels are sluggish, it is advisable to direct the occasional use of a saline cathartic. *Cleanliness* of the mucous membrane is of primary importance, and may be secured by the patient using at home, twice a day, a bland alkaline wash (Formulas 1, 2, 3, 5) with an atomizer.

The application of an alterative or an astringent to the nasal mucous membrane in these cases is of greatest value, and the following formula has long been popular for this purpose:

℞. Iodini	gr. v;
Potassii iodidi	gr. xv;
Glycerinæ	f℥ij.—M.

The result of the application varies according to the amount of the solution used. When the nose is extremely sensitive, only a small amount of cotton should be wrapped about the applicator, so as to form a brush capable of absorbing but a small amount of the solution, which should be carefully applied to those portions of the nasal mucous membrane where the inflammation seems greatest; the cotton brush should also be passed along the floor of the nose and the application painted upon the pharyngeal mucous membrane. After the application of the iodin solution the use of some protective upon the nasal mucous membrane is advisable.

This indication may be secured by means of a spray of fluid albolene, applied until the mucous membrane of the nose and nasopharynx is thoroughly coated with it.

Instead of plain albolene, what is frequently referred to as menthol-camphor-albolene may be employed.

℞	Menthol	gr. v
	Camphor	gr. xx
	Albolene	℥ij.—M.

In certain cases either of the following formulas, when applied to the nose, give quicker and better results than the iodin solution, especially in adults:

℞ Argyrol, 10 to 50 per cent.

℞ Boroglycerid, 50 per cent.

℞ Zinci sulphatis, 2 to 4 per cent.

℞	Acidi tannici	gr. x
	Glycerini	℥j.—M.

Any of these solutions suitably diluted may be injected beneath the middle turbinate or into the superior fossa of the nose by means of a hypodermic syringe with a long malleable silver nozzle (Fig. 28). Because of the close proximity of the structures, solutions remain for a long time by capillary attraction until finally absorbed or removed by exciting an abundant discharge, if sufficiently concentrated to promote exosmosis. For example, 5 per cent. argyrol is largely absorbed, but 50 per cent. argyrol provokes an abundant discharge.

Purulent rhinitis is an inflammation of the Schneiderian membrane in which the discharge from the beginning is purulent. It is more common in children.

Etiology.—It probably always results from specific infection of some kind. It may occur during the course of one of the exanthemata, diphtheria, etc. Some cases occurring in young infants are due to gonorrheal infection from the vagina during birth.

Pathology.—The bacteria characteristic of the infection are found in the discharge or in the mucous membrane. When sufficiently virulent to cause actual destruction of tissue, deep ulcers occur, with final formation of scar-tissue. This disease in childhood is probably the most common cause of atrophic rhinitis in after-life. The adherents of the "Herd" theory believe that a chronic bilateral sinusitis is produced, which is responsible for the formation of crusts in the upper portions of the nose.

Symptoms.—The disease is most common in children and is characterized by a fetid, thin, purulent discharge, sometimes streaked with blood, which often excoriates the lip and alæ of the nose. The nasal mucous membrane is red, swollen, and ulcerated.

Treatment.—The nasal mucous membrane should be cleansed at least twice a day with an alkaline solution by means of an atomizer or syringe.

In infants the nose is more effectively cleansed by means of a medicine-dropper than by the spray from an atomizer, only a few drops being ordinarily necessary for this purpose, and extreme gentleness should be used in syringing in order to prevent fluid entering the middle ear. In children who have not yet learned to blow their nose, it is best to blow it for them by inserting the syringe tip into one nostril and forcibly compressing the syringe-bulb. By this means a current of air is forced into one nostril and out of the other, blowing the mucus and pus before it. After the nose has been cleansed of the secretion, with Dobell's solution, with a small quantity of gallic acid ointment, from 3 to 10 gr. to the ounce of vaselin, according to the age of the child, should then be placed within the nostrils with a brush. This home treatment should be carried out twice a day.

The physician himself should treat the child two or three times a week or oftener by cleansing the nasal mucous membrane as described above, using an air-douche either from a syringe or, in the case of larger children, the Politzer bag to blow mucus from the nose both before and after the use of the atomizer. When thoroughly cleansed, the nose should be sprayed with albolene and dusted with powdered calomel or aristol by means of a powder-blower, care being taken that none of the powder reaches the pharynx and is swallowed.

In scrofulous children hygienic measures are often as important as local treatment. Cod-liver oil, syrup of the hypophosphates, or iodid of iron are indicated in many instances.

Membranous rhinitis is an acute inflammation of the nasal mucous membrane characterized by the formation of a pseudomembrane involving the epithelial and sometimes the subepithelial structures.

Etiology.—The disease is most common among poorly nourished children living in unhygienic surroundings. Occasionally an adult is attacked. The disease is the result of inoculation of the nasal mucous membrane by a micro-organism capable of generating in that locality a pseudomembrane; although it should be borne in mind that the sloughs resulting from galvanocautery wounds, either in the nose or on the tonsils, resemble very closely pseudomembranes; and the same is true to a certain extent of other nasal traumatisms.

Pathology.—The pseudomembrane is generally thick, pulpy, and grayish white, and during the earlier stages is removed with considerable difficulty, leaving a bleeding surface; later, it is more loosely attached and more easily removed. After each removal, if antiseptics are used, a smaller and smaller surface becomes again covered by exudate. The membrane is a meshwork of fibrin entangling leukocytes, degenerated epithelial cells, and micro-organisms. Besides the Klebs-Löffler bacillus, and that resembling it (Hoffman's bacillus), the streptococcus, staphylococcus, pneumococcus, and other micro-organisms are capable of producing a pseudomembranous rhinitis.

Symptoms.—The nasal mucous membrane is greatly swollen and that of the inferior turbinate and adjacent parts of the septum is covered by a pseudomembrane which sometimes involves other portions of the nose. The pharynx is usually almost completely free from pseudomembrane, or there may be one or more small patches, one of which may be on the tonsil. The sufferings of the patient are mostly those resulting from the occluded nostrils. However, the throat is generally somewhat sore and the cervical glands, while not swollen, are tender to the touch and there is sometimes a slight elevation of temperature. Untreated, the disease runs a course of from three to six weeks; under treatment, ten days to two weeks.

Treatment.—The pseudomembrane should be examined by a careful and competent bacteriologist for the presence of virulent Klebs-Löffler bacilli, and if present, antitoxin should be injected, the case isolated, and treated as diphtheria; although primary nasal diphtheria usually runs a mild course, and the danger of inoculating other individuals is probably less than in faucial and laryngeal diphtheria. The writer has never seen an instance in which membranous rhinitis was apparently contracted from an individual similarly affected, although in some instances cases before coming under his care had attended school, and played or even slept with one of their parents or other children. In some of these cases the report of the bacteriologist stated that the Klebs-Löffler was present. However, it is possible that in all these instances the cause of the pseudomembrane was not the Klebs-Löffler bacillus, but that of Hoffman, which is morphologically identical and not an uncommon inhabitant of the nose.

As in the present state of our knowledge it is impossible to make a reliable differentiation between the Klebs-Löffler bacillus and that of Hoffman except by guinea-pig inoculations or some similar test, requiring several days, and as antitoxin, to be most effective, should be used within the first forty-eight hours after the onset of diphtheria, it is possibly better in recent cases, where the bacteriologist reports that the microscopic examination of "smears" shows the presence of a bacillus possibly that of diphtheria, to at once inject antitoxin without waiting several days to determine the result of guinea-pig inoculations. In cases not seen before the pseudomembrane has existed for a week or more, it is better to wait the result of guinea-pig inoculations, as in such cases the probability of antitoxin doing much good is somewhat remote.

In cases where the pseudomembrane is the result of the presence of some other micro-organism than the Klebs-Löffler bacillus, the use of antitoxin is manifestly not indicated. If the cervical glands are inflamed the skin of the neck over them should be kept covered by a 10 per cent. ointment of ichthyol in lanolin until the inflammation subsides. The medical attendant should see his patient at least once a day, and in older children pledgets of cotton saturated with a 3 per cent. solution of cocain should be inserted into each nostril, and after the turbinates have contracted the pseudomembrane should be withdrawn from the nose by means of Politzer's ear forceps (Fig. 159).

After the use of cocain this is usually readily accomplished, especially in the later stages of the disease. After the removal of the membrane the nasal cavities should be washed with Dobell's solution by means of an atomizer yielding a coarse spray, or with a syringe. In very young children it is sometimes impossible to cleanse the nares thoroughly, and the operator will be obliged to content himself by irrigating the nose by means of a medicine-dropper with Dobell's solution or other alkaline wash, to which a small proportion of hydrogen dioxid has been added. After the nasal cavities have been as thoroughly cleansed as can be done with gentleness, the Schneiderian membrane should be sprayed with a 10 per cent. solution of argyrol or powdered calomel insufflated.

Between the physician's visits the treatment should consist either in spraying the nose every three hours with a 10 per cent. solution of argyrol or the insertion into each nostril of an ointment of gallic acid, 3 to 10 grains to the ounce of vaselin, according to the age of the child.

During the attack the child is probably best confined to the house, even in summer, although this is sometimes hard to accomplish when the child's temperature is normal and it feels entirely well except for the discomfort of nasal stenosis. In the more severe cases the child's condition may require that it remain in bed, and in such cases tincture of the chlorid of iron—5 to 10 drops in water every two hours—may be given with advantage, either with or without strychnin.

The slight pharyngitis sometimes present yields to argyrol spraying, or the tonsils may be sufficiently inflamed to require one or more applications of a 10 or 15 per cent. aqueous solution of nitrate of silver.

Hyperplastic rhinitis and **hypertrophic rhinitis** are chronic inflammations of the nasal mucous membrane and submucous tissues with permanent dilatation of the blood-vessels. Hypertrophy of an organ is due to an increase in the size of the cells, while hyperplasia is an increase in the number of cells. Both conditions imply an increase in bulk. In the turbinated bodies of the nose the conditions can be differentiated from the fact that in hypertrophy the parts are soft to the touch and shrink greatly under the application of cocain or adrenalin, while in hyperplasia the parts are firm to the touch and do not shrink greatly under cocain.

Etiology.—These diseases are invariably the result of long-continued simple chronic rhinitis or frequent attacks of coryza.

Pathology.—While in long-continued simple chronic rhinitis there is already some thickening of the epithelial layer of the mucous membrane, yet the disease only becomes hypertrophic rhinitis when the thickening involves the other elements of the mucous membrane and the submucous structures. As the result of frequent attacks of inflammation the blood-vessels become permanently dilated and their walls thickened, glandular tissue is hypertrophied, hyperplasia occurs in the connective tissue, so that the thickened turbinates cannot collapse as when normal, and remain permanently distended with blood. This thickening is most noticeable at the anterior and posterior parts of the middle turbinated bodies, where it is called an anterior or posterior hypertrophy.

Symptoms.—The most prominent symptoms are those of nasal obstruction, want of proper drainage from the nasal cavities, and increased secretions. When the obstruction is great and constant the patient becomes a "mouth-breather." The inspired air, under such circumstances, not being properly warmed, moistened, and freed from dust in its passage through the mouth, causes dry lips, a coated tongue, follicular pharyngitis, and sometimes chronic laryngitis. When the nasal occlusion is complete, the face assumes a stupid expression on account of the constantly open mouth. Any position favoring the gravitation of blood into the hyperemic or hypertrophied parts is sufficient to cause their distention; hence, when the patient is in bed, first one nostril and then the other will become occluded, according to which side of the body is lain upon. This is especially true when large posterior hypertrophies are present. Obstruction and suppuration of the nasal duct not infrequently occur as the result of inflammation beginning at its nasal orifice. An anterior hypertrophy of the middle turbinated body pressing on the septal nerve, a branch of the ophthalmic, frequently causes reflex eye-symptoms, such as chronic conjunctivitis, slight paresis of accommodation; and irritable retina occurs as the result of involvement of the ethmoidal labyrinth. The olfactory slit may become closed from hyperplasia of the middle turbinated body, and thus interfere with the sense of smell and that of taste to a corresponding degree. Redness of the tip of the nose and acne are also in some cases apparently the result of interference with the blood supply of the skin. Hearing may be gravely compromised from the pressure of hypertrophies interfering with the blood supply of the Eustachian tubes, or the extension of the disease to their lining mucous membrane. Headaches are often complained of, and a feeling of pressure or even of pain at the root of the nose.

The patient frequently complains that he has "a bad breath." In many cases the offensive odor is due to decaying epithelium upon the tongue as the result of mouth-breathing or dyspepsia. At other times the "bad breath" of which the patient complains is perceptible only to himself, and is probably due to irritation of the olfactory region of the nose, contrasting strongly in this respect with atrophic rhinitis. If any "catarrhal odor" of the breath of an individual with hypertrophic rhinitis be present, it is always more annoying to himself than to a bystander.

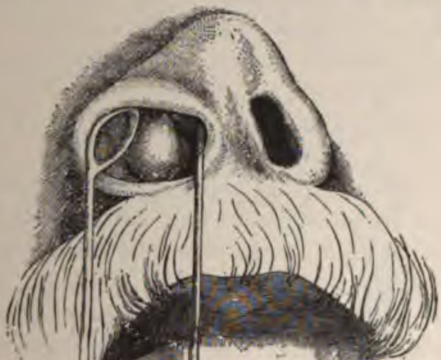

Fig. 41.—Anterior hypertrophy of the inferior turbinate (Seiler).

Treatment.—Each case should be treated as one of simple chronic rhinitis until the inflammation of the Schneiderian membrane has disappeared, when operations should be undertaken for the removal of any tissue causing obstruction.

Removal of Anterior Hypertrophies.—If large, especially if the hypertrophy consists of hyperplastic tissue, that is, tissue that does not contract when cocain is applied, their removal with scissors or snare will be found most satisfactory.

Another method of removing anterior hypertrophies is by the *galvanocautery*. A pledget of absorbent cotton, saturated with a 3 per cent. solution of cocain, is introduced into the inferior meatus and allowed to remain in contact with the hypertrophy until it has shrunken as much as possible and the parts are thoroughly anesthetized. A metal speculum is introduced after the removal of the cotton and the hypertrophy exposed. After the platinum wire of the cautery-knife is at a dull-red heat, it is placed upon the thickest part of the hypertrophy, and by means of gentle to-and-fro movements is made to cut through to the bone, when it is carefully withdrawn, so as not to detach the eschar which it has formed. The operator should be careful to cut down to the periosteum before withdrawing his cautery-knife or the results of the operation will be far from satisfactory; for, although a superficial burn either with the galvanocautery or chromic acid heals very quickly and gives a certain amount of relief for a short time, yet the results are not as permanent as when the cautery-knife is made to penetrate the periosteum.

No after-treatment is required beyond keeping the wound as dry as possible and endeavoring to avoid detaching the eschar before the healing process has been completed beneath it.

Although nearly six weeks are sometimes required for the complete healing of a cautery wound, yet

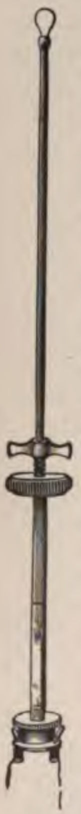

Fig. 42.—Jarvis' snare. The figure shows a small, light snare: what might be called the "standard" snare for nasal work. It should be forged from steel and not constructed of brass with a steel tip. For ordinary nasal work it is threaded with No. 5 American steel piano wire, which, while not as strong, is somewhat more pliable than the imported. However, many operators prefer Krause's snare or some similar type, which permits the same wire loop being used a number of times.

little inconvenience is usually experienced by the patient during the healing process, except that during the first week the nostril is sometimes more obstructed than ever as the result of swelling. At the end of about ten days the slough produced by the burning separates from the wound and decided advantage from cauterization is then first experienced. The improved respiration becomes greater and greater until the wound is finally entirely healed. The anterior portion of the turbinate then presents a somewhat pale appearance, with a depression indicating the seat of the cautery application. The turbinate not only is diminished in size, but sudden change in its volume, with consequent obstruction of the nostril, is also prevented. The patient states he "does not 'catch cold' as readily as before the operation."

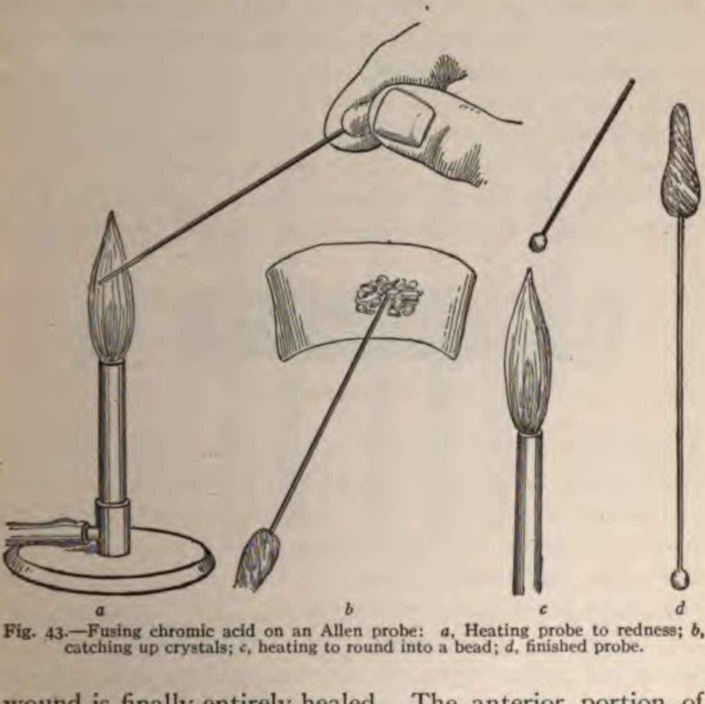

Fig. 43.—Fusing chromic acid on an Allen probe: *a*, Heating probe to redness; *b*, catching up crystals; *c*, heating to round into a bead; *d*, finished probe.

The galvanocautery should be used cautiously upon the middle turbinated bone, only a very small knife being employed for the purpose. Its application to the posterior portion of the nose is best avoided. Because of the thinness of the cartilaginous septum and the low vitality of its cartilage deep cautery wounds generally result in a perforation. Because of the edema that sometimes results the cautery should not be used on the uvula, the anterior pillars of the fauces, the arytenoids, or the glosso-epiglottic folds except with extreme caution. It is permissible to remove a little mass of mycosis by means of the galvanocautery from these regions, but a very small cautery-knife should be employed and the burn should be very superficial.

Chromic acid is more frequently employed than any other chemic caustic in the treatment of anterior hypertrophies.

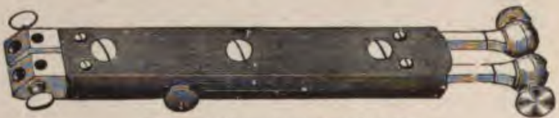

Fig. 44.—Galvanocautery handle.

It should be used in the following manner: The end of an Allen probe (Fig. 43) is heated and plunged into a bottle containing crystals of chromic acid, some of which will adhere to the probe and be withdrawn with it from the bottle. A further application of heat will fuse these crystals upon the probe, which is now ready for use. The probe may also be prepared for use as a cautery by wrapping a few fibers of absorbent cotton about its end and rubbing into it moist powdered crystals of chromic acid until the cotton is saturated with the paste.

The parts having been cocainized, the end of the probe, covered with chromic acid, is pressed firmly into the hypertrophy and pushed backward and forward over the line to be cauterized, and finally withdrawn. After the lapse of a few moments the nasal chamber is thoroughly washed with the spray from an atomizer containing an alkaline solution, care being taken that none of the resulting chromic salt reaches the pharynx and is swallowed, as it is poisonous.

Chromic acid is more uncertain in its action than the galvanocautery-knife, and the same is true of *trichloracetic acid*, which is used in practically the same manner, except that, being a liquid, it cannot be fused on to the end of a probe.

When the rhinologist's office is lighted from the wires of an electric supply station some form of "converter" may be used to secure a current suitable for the galvanocautery, snare, miniature lamps, and electric motor. Apparatus also may be purchased for obtaining from the company's wires both a suitable galvanic and faradic current for medicinal purposes.

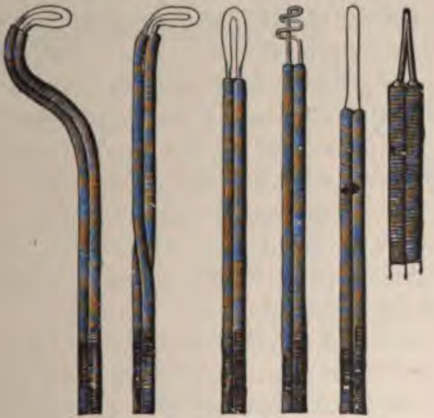

Fig. 45.—Cautery-knives.

Removal of Posterior Hypertrophies.—A Jarvis snare should be threaded with No. 5 steel piano wire. The loop of wire should be bent to one side before being introduced into the nostril, so that it may the more readily be passed around the hypertrophy and remain in position when the loop is tightened. Being made as small as possible without distorting it by pulling down the sliding tube upon the handle of the instrument, the loop is carefully introduced along the floor of the nose until the posterior wall of the pharynx is reached, when the loop is again enlarged by pushing upward the sliding tube, and the instrument at the same time is slowly withdrawn as its handle is carried toward the septum. By this means the wire is made to surround the hypertrophy and a resistance is finally felt as the instrument is withdrawn, caused by the bight of the loop coming in contact with the base of the hypertrophy. The wire loop is now quickly tightened around the hypertrophy by pushing forward the instrument within the sliding tube, and the milled nut is quickly screwed downward into place. Two or three additional turns are given to the milled nut to be certain that the wire is tight about the base of the growth and that the instrument is held firmly in place without danger of slipping, when the patient may be allowed to rest. The sudden tightening of the wire loop occasions the patient some pain, which, however, soon subsides, when the loop may be still further tightened by turning the milled nut until the patient begins to again experience pain. In this way, proceeding slowly and carefully, the hypertrophy is finally squeezed off from its attachment, and is generally removed clinging to the end of the instrument by some fibers that have been drawn down into it with the wire. However, should the growth not be removed with the instrument, no attempt should be made to dislodge it from the nose, as it forms an efficient plug to prevent hemorrhage, and will probably drop into the fauces and be expectorated within twenty-four hours after the operation. Owing to the compression of the wire, the wound made by snaring a posterior hypertrophy is but small and generally heals rapidly. Cocain should not be used as a local anesthetic for the removal of posterior hypertrophies, because it shrinks the tissues to such an ex- t that it is difficult to grasp the hypertrophy with the re. A 10 per cent. solution of stovain or alypin does not contract the tissues and hence is the preferable anesthetic for this operation.

Turbinectomy, or removal of the whole or, at least, the greater portion of the inferior turbinated body, is performed to secure increased breathing space, for the removal of malignant growths, and for other reasons. *Turbinotomy*, or the removal of a portion of the inferior turbinate by the snare, galvanocautery, and chemic caustics, has been described already. When these methods are inadequate to remedy stenosis, a larger portion may be removed with a swivel knife (Fig. 58), which is applied as near the posterior extremity of the turbinate as deemed necessary and pushed upward through the tissues to the desired depth and then drawn forward parallel to the lower border of the turbinate, so that a long strip of tissue is cut away. The same result is accomplished with a "spoke shave," an instrument similar to Fig. 58, except that its cutting edge does not swing, but is fixed and immobile.

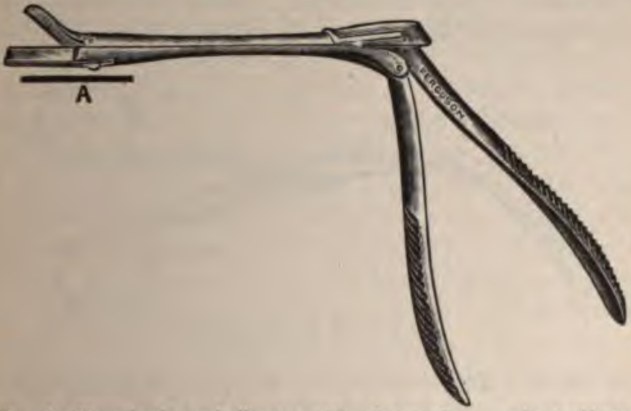

Fig. 46.—Struycken's nasal alligator cutting forceps, for removing turbinates.

When sufficient nasal respiration can be secured by operations on the septum, such as the removal of an exostosis or bringing a septal deviation into the median line, it is better not to remove any large portion of the inferior turbinated body because of the great destruction of mucous membrane and erectile tissue.

Moreover, a turbinectomy done to relieve the stenosis caused by a deviated septum would accomplish nothing toward improving the condition of the wider nostril. As a matter of fact, when middle-ear catarrh results from deviation of the nasal septum, it frequently begins in the ear of the same side as the wider naris.

The operation of turbinectomy is best done in the following manner: The nasal mucous membrane is cleansed with spray from an atomizer containing Dobell's solution or some other suitable alkaline fluid. The upper and lower portion of the attachment of the inferior turbinate is now cocainized by rubbing into them by means of a cotton-tipped applicator a 10 per cent. solution of cocain in 1 : 2000 adrenalin solution. One blade of Struycken's cutting forceps (Fig. 46) or, better, a stout pair of nasal scissors (Fig. 47) is inserted beneath the anterior extremity of the turbinate in a direction upward and somewhat backward and the anterior attachment of the bone severed. The cutting is continued backward in a direction parallel to the floor of the nose until the inferior turbinate is completely severed from its attachment to the lateral wall of the nose. It is then removed with a pair of forceps. The hemorrhage is frequently trifling.

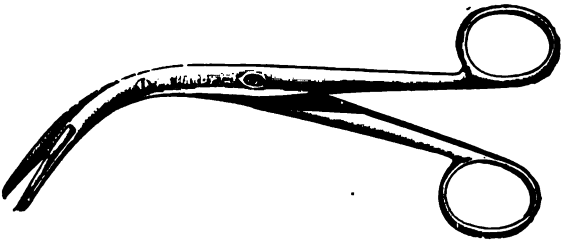

Fig. 47.—Beckmann's scissors.

It should be remembered that while the anterior attachment of the middle turbinate is nearly vertical, that of the inferior is obliquely upward and backward.

Simpson's tampon or a longer strip of Bernay's sponge (Fig. 51) is inserted into the nostril, where it is allowed to remain for twenty-four hours.

Ecchondroses and Exostoses of the Septum.—A localized cartilaginous thickening or projection from the cartilaginous septum is called an ecchondrosis, while a similar bony growth upon the bony septum is referred to as an exostosis or hyperplastic osteoma. Heteroplastic osteoma is a name given to rather a rare form of bony nasal growth which springs from the cellular tissue beneath the mucous membrane, is not continuous with the cartilaginous or bony framework of the nose, and is, therefore, movable. Frequently, ridges or shelves of cartilage and bone are found extending along the septum nearly from the anterior to the posterior nares. Usually such growths follow the suture between the vomer and superior maxillary or that between the triangular cartilage and the vomer. (See Vomerine Crest, p. 58.)

Etiology.—They are, doubtless, sometimes merely provisional callus that has escaped absorption and has been deposited upon an old traumatism of the septum, which may have been received during early childhood as the result of one of the numerous "bumps upon the nose" that children are constantly receiving.

Symptoms.—Frequent nasal obstruction. Atrophy of the turbinated body opposite them is not uncommon, or neuralgia of the whole side of the face, as the result of intranasal pressure. Sometimes the crest of such growths is ulcerated, and a thin, irritating, sanious discharge results, impossible to cure except by the removal of the exostosis or ecchondrosis. The nostril being obstructed in front, the breath current is interfered with in such a way that there is a constant rarefaction of the air at the orifice of the eustachian tube at each inspiration, and as the result of "vacuum congestion" tinnitus and, finally, otitis media and deafness result.

Operations.—Localized thickenings of the cartilaginous septum may be cut through and removed by means of a small probe-pointed tenotome. When the growth is hard and bony it is best removed by means of a chisel or saw. It should be borne in mind that only that portion of the growth should be removed which interferes with proper nasal respiration. This, of course, means, in most instances, the whole of the growth. In a roomy nostril, however, and in atrophic rhinitis the growth may in some instances be doing good by occupying a certain amount of space in a nostril already too large, and under such circumstances its removal would probably cause postnasal catarrh and chronic pharyngitis.

The parts to be operated upon should be exposed by means of a dilator (Fig. 17), which will be found convenient for operations within the nose, because when once in position it is not easily displaced by the grimaces of the patient during an operation. The field of operation is then rubbed with a cotton-tipped probe which is moistened in 1 : 1000 adrenalin solution and dipped into coarsely powdered cocain.

When the saw is used, it should be entered *below* the growth and the sawing done in an upward direction, so as to obscure the field of operation as little as possible by blood, which, of course, flows downward from the wound. When the shelf of bone is large and hard the operation is necessarily tedious; but at any stage of the operation the saw may be withdrawn and both operator and patient rest, a plug of absorbent cotton saturated with a solution of adrenalin being inserted within the nostril. Under these circumstances the nostril will be found free from blood when the cotton is withdrawn, so that the operator can readily see to replace the saw in the cut already made. It is possible in some instances to secure a practically bloodless operation; but it should be borne in mind that adrenalin contracts only the more superficial vessels, and that if a large vessel is severed, especially one deeply embedded in bone, the hemorrhage may be severe. Under such circumstances the operation should be completed as speedily as possible and the severed mass of bone removed. A Simpson nasal tampon (Fig. 51) should then be placed within the nose, but should this prove insufficient, the case should be treated as described in the section on Nasal Hemorrhage.

A large variety of nasal saws are for sale in instrument stores. Those shown in Fig. 48 are typic as to arrangement of the teeth. The saw blades should be thin but rigid, and therefore somewhat wide, especially near the handle. Occasionally a narrow saw is required to commence the sawing of an exostosis too close to the floor of the nose to permit the introduction of a wider instrument. To prevent binding in the tissues, the cutting edge of the saw should either be thicker than the back, as in metacarpal saws, or the teeth will require "setting," as in ordinary carpenter's saws. Clogging of the teeth with sawdust occurs in all saws, but is best prevented by the arrangement of the teeth in the Sajous saw. Hence this saw penetrates hard bone more rapidly than the others and is a preferable instrument when an ex-

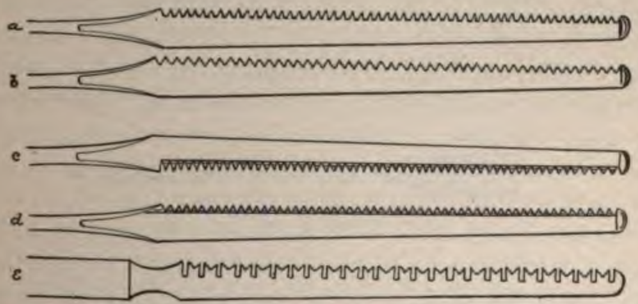

Fig. 48.—Nasal saws: *a*, Bosworth's saw. The three varieties have teeth which are either "straight cutting," "back cutting," or "front cutting"; *b*, Bucklin's saw. The teeth are arranged like those of a metacarpal saw; *c*, *d*, Hall's saws, right and left, are beveled on the cutting edge, so that these saws may be sharpened on a stone in the same way as a knife; *e*, Sajous' saw. Has teeth arranged like the double-handled large cross-cut saws used by lumbermen to saw logs. This arrangement of the teeth prevents them from being clogged by sawdust, and hence Sajous' saw penetrates bone more rapidly than the others.

ostosis is large or much sawing has to be done, as in the author's operation for deviated septum. Hall's saws and the beveled saw blades of Pynchon are excellent for small soft exostosis. To avoid leverage the sawing should be done as much as possible with the teeth nearest the operator's hand, and the saw teeth should extend up somewhat closely to the handle of the instrument (Fig. 48, *e*).

Not infrequently, after the bone has been completely severed, it will be found difficult to cut with the saw shreds of mucous membrane by which it is still attached to the septum. These shreds usually can be easily cut with the nasal scissors. However, in most instances the snare (Fig. 42) is by far the preferable instrument. It is especially useful in cases where a small exostosis has apparently been completely severed, but has disappeared from view in the blood within the nose. In some of these cases it is difficult to locate and grasp the mass with forceps, and impossible for the patient to blow it from the nostril because of a shred or two of uncut membrane; under these circumstances if the wire loop of a snare is passed beyond the position of the exostosis and then kept closely in contact with the septum, the loop will hardly fail to encircle any shreds that still connect the exostosis to the septum, and after these are severed by closing the loop the exostosis usually is withdrawn from the nose with the snare by means of fibers that have been drawn into the tube of the snare.

Ecchondroses occupying only the anterior portion of the septum are best removed by a submucous operation, which is readily done by incising the mucous horizontally along the crest of the growth and elevating that above the crest with a probe-pointed tenotome. No attention need be paid to the mucous membrane below the crest, as that above is usually sufficient to cover the wound. The cartilage or bone is then removed with knife or saw and the mucous membrane replaced over the wound. Except that such wounds heal more quickly than when the mucous membrane has not been sacrificed, the method has no advantages except at the extreme anterior portion of the septum. In this locality the removal of much mucous membrane is often followed by annoying crust formations which may persist for many months or years.

Drills.—The motive power for the drill is supplied through a flexible armpiece (such as is used by dentists) by a small electromotor.

The operation with the drill is performed in the following manner: After cocainization of the field of operation as already described, a trephine sufficiently large to remove at once the major portion of the exostosis is selected, and with its shield is adjusted to the armpiece of the electric motor in such a manner that the shield will protect all parts of the nose from injury except those to be cut away. The teeth of the trephine are now pressed into the anterior part of the growth, and as the instrument is pushed forward a piece of bone is cut from the exostosis, which enters the cavity of the trephine, where a knife set at an angle cuts it into pieces sufficiently small to pass through a fenestra made for this purpose. Should a sufficient amount of the growth not be removed by the first passage of the trephine through the nasal fossa, the trephine may be reapplied as often as may be necessary to remove the entire exostosis and leave a smooth, flat surface like that made by a saw.

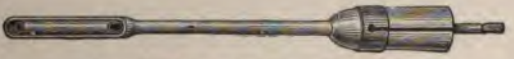

Fig. 49.—Gleason's electric-motor drill.

When an ecchondrosis or exostosis has attached itself to the inferior turbinated bone, so that a synechia or "bridge" extends from the septum to the opposite side of the nostril, it is perhaps best removed by first sawing through the portion next the septum, then snaring the attachment to the turbinate. Unfortunately, after such an operation the "bridge" is very liable to recur, owing to the granulations from the cut surfaces of each side of the nostril approaching each other during the healing process until they finally unite. To prevent this disaster, a steel probe may be used to break down the adhesions, or a piece of tin-foil or gutta-percha may be worn inside the nose between the cut surfaces until the healing process is complete. Ordinarily, nasal operations, either with saw or chisel, require no after-treatment besides the free use of an alkaline wash by the patient, in order to keep the wound clean. There is but little inflammatory reaction and the wounds heal promptly.

Packing the nose with iodoform gauze or any other substance after a nasal operation should be avoided if possible. It is only permissible to check hemorrhage or when the patient has to travel a considerable distance after leaving the surgeon's office before reaching home. Under such circumstances a narrow strip of iodoform gauze, previously saturated with fluid albolene, should be placed in the nose in such a manner as to make gentle pressure upon the wound. Such a packing can generally be removed without hemorrhage, in from twelve to twenty-four hours, if care is taken to remove it gradually, so as not to remove the pressure from the wound too suddenly.

When no dressing is used, which is by far the preferable method, blood-stained mucus is blown from the nose for some days after the operation.

Atrophic rhinitis is an atrophic condition of the nasal mucous membrane, usually also of the submucous tissues, and the turbinated bones and septum. In some cases because of a faulty development of the shape of the nose the nostrils look forward instead of downward. The disease is characterized by a lessening in the size and thickness of the intranasal anatomy, a change in the color of the mucous membrane, a replacement of ciliated by squamous epithelium, and partial loss of function as the result of a decrease in the number of component cells, hence diminished secretion and the formation of crusts of inspissated and putrid mucus which emit a fetid and offensive odor.

Etiology.—Atrophic rhinitis is said to result from long-continued hypertrophic rhinitis, but the author never observed hypertrophic rhinitis assume the atrophic form except in a syphilitic; where, after the loss of the major portion of the septum, the nose presented a characteristic atrophic appearance, with loss of the sense of smell and crust formation. Meissner states that atrophic rhinitis is the result of a *primitive* or broad shallow nose, and to *congenital* development of pavement instead of columnar mucus-producing epithelium. An abnormal dryness of the atmosphere, like that produced by hot-air heaters, abnormal patulency of the nares, or anything else that causes a rapid evaporation of the nasal secretions, tend to produce atrophic rhinitis to the extent that some cases are free from symptoms while at the seashore. It is noticeable that the "atrophic rhinitis" resulting from extensive destructions of mucous membrane by radical operations on the ethmoid are not always followed by crust formation and ozena, and it is probable that the bacteria which swarm in the secretions play the most important rôle in the disease. Any infection virulent enough to destroy a sufficiently large area of mucous membrane will produce atrophic rhinitis, and a considerable proportion of cases begin in childhood as a purulent or pseudomembranous rhinitis.

Pathology.—As the result of the increased size of the nasal chambers the scanty secretions rapidly evaporate and, mixed with the inhaled dust, accumulate upon the mucous membrane, forming bad-smelling scabs and crusts. Owing to pressure from these scabs, shallow ulcers occur beneath them, while the atrophy progresses by the destruction of glands, nerves, blood-vessels, connective tissue, and bone until, in some cases, the turbinates have nearly disappeared and the septum has become, at certain parts, almost as thin as a sheet of writing paper. It is not uncommon for individuals to present themselves to the surgeon with hypertrophic catarrh existing in one nasal cavity, while atrophic rhinitis is present in the other. In such cases there is usually deviation of the septum toward the hypertrophic side. Cases are not infrequently seen with an inferior turbinated body and the adjacent mucous membrane atrophied, while the middle turbinated body immediately above is greatly hypertrophied.

Concomitant disease of the ethmoid cells or of some one or more of the other accessory sinuses of the nose is not uncommon in atrophic rhinitis, and may be either the cause or result of the disease. Retained secretions putrefy and produce a characteristic odor, horribly offensive, the disease being then termed "ozena." Similar stenches occur in syphilitics, the stench resulting usually not from fetid semi-inspissated mucus, but from sequestra of dead bone within the nose.

Somewhat numerous varieties of bacteria are found in the secretions of atrophic rhinitis, the saprophytes, or those causing putrefaction, naturally being the most numerous. The Klebs-Löffler bacillus or that of Hoffman is frequently found. Attention has been called to the large proportion of cases of pulmonary tuberculosis among patients with atrophic rhinitis. It has been suggested that the large proportion of consumptives is due to the fact that atrophic rhinitis deprives the nose of its power to arrest and destroy the bacteria of inspired air; but improvement in some cases of ozena not complicated by lung lesions has followed treatment with tuberculin. However, the bacillus of Perez and that of Abel are probably pathognomonic and good results have been reported as following the use of vaccines containing these micro-organisms. Both are capable of producing the characteristic odor of ozena when grown on suitable media by the production of organic sulphites, especially mercaptans.

Symptoms.—A sensation of dryness and irritation within the nose and pharyngeal vault, with frequent efforts to remove the accumulated secretions by hawking, spitting, and blowing the nose. The breath is usually fetid, but the patient, because of his defective sense of smell, is unaware that his breath is horribly offensive. Upon inspection, the mucous membrane is found dry and glazed, with scabs and pus adhering to certain portions of it. Sometimes the nostrils are so patulous that the posterior pharyngeal wall can be plainly seen through them, and it is also usually in an atrophic condition. Yet, notwithstanding the patulous nares, patients usually complain of an inability to breathe through the nose. Reflex skin rashes, pharyngitis, and laryngitis are very common as the result of this affection.

Treatment.—The indications are to secure and maintain absolute cleanliness of the nasal mucous membrane, and replace, if possible, the atrophied parts. Cleanliness may be secured by syringing with an alkaline wash. When the patient is wearing Gottstein's cotton cylinders within the nose there is usually no trouble in removing the secretions, as crusts usually cease to form.

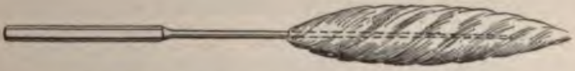

Fig. 50.—Allen's nasal applicator with Gottstein's cotton plug ready to be deposited inside the nose. After the cotton is within the nose the probe is detached from the cotton and withdrawn by turning it in a direction opposite to that by which the cotton was wrapped.

In some cases good results are obtained in the treatment of atrophic rhinitis by the use of absorbent cotton, as first advocated by Gottstein (Fig. 50), so placed inside the nose as to perform the functions to a certain extent of the atrophied turbinated bodies. If pharyngitis sicca is present, the cotton cylinders should be of sufficient length to extend the entire length of the nasal floor and project somewhat from the posterior nares. The presence of the cotton cylinders excites the atrophied mucous membrane to renewed action, so that the dried secretions are washed away in the increased discharge and the fetor of the breath corrected. The cotton cylinders soon become soaked with mucus, so that the air passing around them is warmed, moistened, and freed from dust, and enters the pharynx and larynx as if it had passed through a healthy nose.

A cotton cylinder is easily made by loosely wrapping absorbent cotton about an applicator (Fig. 50) until it has assumed the desired bulk and shape. The cotton is then placed inside the nose and the applicator removed by turning it in a direction opposite to that by which the cotton was wrapped about it. The patient should be taught how to make and place these cotton cylinders inside his nose, and should insert fresh ones as soon as the old are removed by the use of the handkerchief. If worn constantly they cause an immediate change for the better in all the symptoms. However, a very large proportion of patients are unable to properly use this cotton.

The condition of the accessory sinuses should be carefully investigated, and if diseased, receive appropriate treatment. However, the use of suction (page 190) usually does good, even in cases where the sinuses are not suppurating, by producing artificial congestion of the nasal mucous membrane with an outflow of thin mucus which tends to lessen crusting of the parts. Most cases of atrophic rhinitis are very sensitive to suction and cannot stand without pain more than 8 to 12 degrees of negative pressure as measured by a vacuum gage. Good results have been reported from the use of autogenous vaccines.

If practical, the patient should adopt an outdoor employment away from dust and, if possible, near the seashore.

So numerous are the drugs that have been used in the local treatment of atrophic rhinitis that a catalogue of their names and combinations would fill several pages. Among the best is scarlet red ointment. As most drugs and formulæ that are antiseptic and slightly stimulating afford at least temporary relief, the composition of the remedy is probably of much less importance than the thoroughness with which it is applied to the angles beneath the remains of the middle turbinates and other not readily accessible parts of the nose. Nitrate of silver solutions have been used for many years in the treatment of atrophic rhinitis and there seems a tendency to return to their employment. After the nose has been cleansed of crusts, an applicator with a small, somewhat firmly wrapped piece of cotton is dipped into a 10 per cent. solution of nitrate of silver and after being freed from drip is pressed into all accessible portions of the upper portion of the nose, especial attention being directed to locations in which accumulations occur. In such places the remedy is massaged, as it were, into the tissues by recurrent pressure with the applicator; 2 up to 15 per cent. nitrate of silver may be used, but when the stronger solution is employed, great care should be taken that there is no drip expressed from the cotton to reach the pharynx and larynx.

Attempts have been made with no great success to restore the original bulk of the turbinals by the injection of paraffin wax (Formula 85) underneath the nasal mucous membrane.

Prognosis.—Atrophic rhinitis is one of the most unsatisfactory and tedious of nasal diseases to treat.

The author occasionally sees cases that he treated ten or more years ago. Some of these cases are cured to the extent that there is no fetor of the breath or retained secretions requiring removal, except during periods when the patient has caught cold.

Syphilitic rhinitis is a diseased condition of the interior of the nose dependent upon the presence of the Spirochæta pallida.

Pathology.—It is exceedingly rare to find the primary lesion of syphilis existing inside the nose, from the fact that the syphilitic virus is rarely introduced inside the nasal chambers, and that, should such an event occur, the secretions of the parts tend to wash away the morbid matter before inoculation takes place. Secondary lesions of the nasal mucous membrane are analogous to, and often coincide with, those appearing upon the skin. They vary from a mere erythema of the nasal mucous membrane with increased secretion to intense hyperemia and swelling, with the presence of mucous patches or shallow ulcers, secreting a sanious and offensive mucopus. During the tertiary period nasal gummata are by no means rare. They appear as irregular nodulated swellings distending the mucous membrane of any part of the interior of the nose. A nasal gumma may be absorbed, leaving in some instances a characteristic stellate cicatricial contraction, or it may break down and produce an ulcer, before which the cartilages and even the bony structures of the nose may melt away like wax as the ulceration rapidly extends, thus producing in a marvelously short time the most hideous deformity. Exuberant granulations may spring from the ulcerating gumma and completely fill the nasal chamber or even project from the nares, simulating a malignant growth. When the ethmoid has thus been necrosed and exfoliated, there may remain, after the healing process is complete, but a thin fibrous membrane between the interior of the nose and the brain. The lateral wall of the nose may be destroyed entirely, so that the antrum of Highmore and the affected side of the nose become one large cavity. In other instances the septum, nasal processes of the superior maxillary, and the nasal bones may be partly destroyed in such a manner that the nose becomes flattened upon the face, producing a most serious deformity. In aggravated cases the soft parts may also be involved in the process, until finally the anterior nares are represented merely by an irregular hole in the face. During the ulcerative process of a gumma the breath is generally offensive. Hereditary syphilis pursues the same course as the tertiary form of the acquired disease.

Treatment.—Constitutional treatment is of primary importance. Prompt amelioration of symptoms follows the injection of salvarsan or neosalvarsan, especially in the primary and secondary stages of the disease. In the primary stage the injections are sometimes curative. If there be a negative Wasserman reaction at the time of the injection there is a possibility that it will remain negative indefinitely after a single injection. But injections of salvarsan or neosalvarsan are not usually curative after the spirochetes have invaded the general system. At least four weekly injections should be made should the Wassermann test continue strongly positive, and then suitable treatment with mercury or mercury and iodid of potassium commenced. At all stages of the treatment the progress may be estimated by Wassermann reactions which are more useful for this purpose than diagnosis, because faintly one plus results are sometimes obtained on non-syphilitic individuals and negative Wassermanns are sometimes obtained in individuals with manifest tertiary lesions. The chief advantage of salvarsan over mercury is the greater rapidity with which manifest lesions disappear; but the number of negative reactions after a course of four to six weekly injections is extremely small, but is increased somewhat by a course of mercury. Under these circumstances which of the drugs should receive the credit of the "cure"?

Mercury may be given internally as a pill containing $\frac{1}{4}$ gr. of the protoiodid of mercury (Formula 23). The patient may take from one to three of these pills three or four times a day, and, if necessary, a sufficient quantity of opium should be administered to prevent their producing diarrhea. The pills are less likely to produce digestive derangements if taken after meals and at bedtime.

In tertiary syphilitic rhinitis the *mixed treatment* answers a very useful purpose, for, while the iodid of potassium is not a specific in syphilis in the sense that mercury is, yet it gives a much quicker result in controlling tertiary manifestations. One, two, or three teaspoonfuls of Formula 22 may be given three or four times a day, according to the emergencies of the case and the patient's susceptibility to mercury. Mercury may also at the same time be administered by inunctions, which are perhaps the most reliable and comfortable to the patient of any method of treating syphilis, as it rarely disturbs the digestion or causes ptyalism and can be used at any stage of the disease. However, it stains the underclothing, and hence leads to the detection of the patient's condition by other members of the household. The patient prepares for a course of one week's inunctions by a preliminary hot bath and then each night rubs into the skin of the belly, chest, or back 1 dram of freshly prepared and scented mercurial ointment. The undershirt is not changed, but worn constantly during the week. At the end of this period the inunctions are either suspended for some days or weeks or continued at the discretion of the physician. Mercury may be administered hypodermically by injecting mercury salicylate deep into the muscles of the buttock, beginning with 1 gr. and gradually increasing to 1½ grs., or mercurialized serum may be used for the same purpose, and is said to be less irritating. When a nasal gumma has broken down and is ulcerating, the parts should be kept scrupulously clean by the use of an alkaline solution, and the wound stimulated to heal by the daily application of acid nitrate of mercury diluted with 8 parts of water.

Goundou, henpue, or dog nose is a proliferating periostitis beginning in the nasal processes. It usually follows and is probably identical with frambesia or yaws, which is a tropical, contagious skin disease due to constitutional infection with a spirillum. The primary sore is usually extragenital. The secondary skin lesions from their resemblance to raspberries give the name yaws to the disease. The lesions of the tertiary stage closely simulate those of syphilis, but the Wassermann reaction is negative. It is most common and fatal in children. Adults seldom die from it.

Treatment consists in the administration of iodid of potassium. Mercury is said to be useless. Nasal hyperosities may require removal by the chisel or rongeur forceps.

Tubercular rhinitis is an inflammation of the interior of the nose characterized by the presence of tubercle bacilli.

Etiology.—The disease is usually the result of the inoculation of the nasal mucous membrane by morbid material from another portion of the body of a tuberculous individual.

Pathology.—The most common lesion observed is a small ulceration, usually on the septum or floor of the nose. Occasionally hyperplastic nodules and papillomata, pale in color and either pedunculated or sessile, are observed.

Symptoms.—Crusts form upon the ulcerations and are blown from the nose. The ulceration may progress to perforation of the septum. The hyperplastic growths sometimes attain sufficient size to cause nasal obstruction.

Diagnosis.—The disease in its ulcerative form somewhat resembles syphilis; but as it rarely occurs except in individuals with advanced pulmonary tuberculosis, the diagnosis usually is easy. The surrounding mucous membrane is much paler than in syphilis; indeed, the whole mucous membrane of the nose is usually anemic. In doubtful cases, iodid of potassium exhibited for a few days in 10-gr. doses every three or four hours will usually decide as to whether syphilis is the cause of the ulceration. However, it should be remembered that tuberculous individuals frequently do badly under iodid of potash, and the "therapeutic test" should, therefore, be used with care to prevent irreparable damage. The Wassermann reaction, while only conclusive if positive, is preferable in advanced cases, and it is better in practically all cases when the diagnosis between syphilis and tuberculosis is doubtful to test for syphilis before resorting to the tuberculin test (see page 584). Papillomatous outgrowths examined microscopically show the presence of tubercle bacilli.

Treatment.—The local treatment consists of cleanliness of the nasal cavities by the patient's use of an atomizer containing an alkaline wash, followed by spraying the nose with menthol-camphor-albolene. The physician may cleanse the ulcerations and touch them with solid nitrate of silver fused on the end of a probe (Fig. 43). Large papilloma may be snared, but it is advisable to do no unnecessary surgery in a tuberculous nose. As the disease rarely, if ever, occurs except in advanced pulmonary tuberculosis, the general treatment is more important than the local.

Lupus.—The name lupus is applied somewhat loosely to various skin diseases: Lupus erythematosa, lupus congestiva, lupus superficialis, lupus sebaceus. Lupus erythematosa first appears as grouped red spots that ultimately coalesce into slightly raised patches. The initial lesion is always erythematous and, unlike lupus vulgaris, there is no tendency toward ulceration.

Lupus vulgaris sometimes originates at the tip of the nose, either upon the mucous or, more often, on the skin surface.

Etiology.—The cause of the disease is the tubercle bacillus.

Pathology.—The lesion manifests itself as reddish-brown nodules. These atrophy, leaving scars, or ulcerate, involving sometimes large areas of skin, mucous membrane, and cartilage. A large portion of the tip of the nose and septum may be destroyed. The ulcer is often covered by a brownish scab; when this is removed the ulcer appears filled with a granular "applejelly"-like mass, which can be readily scraped away with a curet. Deep cicatrices and deformities result from the healing of the ulcer. It may cicatrize at one extremity, while the progress of the ulceration is active at the other. The disease is uncommon in America.

Diagnosis.—Lupus so much resembles syphilis that the diagnosis usually has to be established by the Wassermann reaction, or the exhibition of iodid of potassium. From epithelioma it is differentiated by the microscopic findings.

Treatment consists in the daily application of the *x*-ray.

Rhinoscleroma is a disease of the mucous membrane of the nose extremely rare in North America, but occurring in Brazil, Russia, Italy, and other countries.

Etiology.—According to some authorities the disease is the result of the presence of a characteristic bacillus.

Pathology.—The disease produces nodular hypertrophies on the nose and sometimes within the nose, pharynx, and larynx. Ulcers appear upon the mucous surfaces resembling the lesions of tertiary syphilis. The contraction of dense cicatrices sometimes results in deformities.

Symptoms.—There is little or no pain at any stage of the disease. The growth inside the nose may interfere with nasal respiration, and when the mouth and pharynx are involved it may be impossible for the patient to swallow solids. Involvement of the larynx may be sufficient to interfere with respiration as the result of cicatricial contraction.

Treatment.—As the disease has a tendency to recur, operative interference is inadvisable, except tracheotomy when necessary to prevent death from stenosis of the larynx. Lang recommends salicylic acid locally and in 10-gr. doses internally.

Leprosy of the Nose.—According to Sticker and others the nose in the earlier stages of leprosy is the site of lesions discharging leprous bacilli, and while the statement that the *initial lesion* is usually upon the nasal septum has not been proved by clinical observation, yet, as stated by Brinkerhoff and Moor, "When it is not practicable to make a complete physical examination of all individuals of a class suspected of leprosy, the examination of the nasal septum and the bacteriologic examination of the nasal secretions will prove of value by permitting the recognition of the most dangerous type of the disease, and is therefore worth while even if it does not reveal all cases of the disease in those who come under observation."

The theory that the initial lesion is usually nasal is probably untenable. H. T. Hollman, one of the physicians in the Kalanpapa Leper Colony, Hawaiian Islands, states that in an early stage of the disease the symptoms are those of hypertrophic rhinitis, the nasal chambers being sometimes completely occluded by the swollen turbinates. Sometimes small tubercles are present that degenerate into small-sized ulcers, which, however, heal nicely under appropriate local treatment. In neglected cases the symptoms do not differ from those of ordinary atrophic rhinitis: there is atrophy, foul-smelling accumulations, and loss of the sense of smell. Perforations involving in some cases nearly the entire septum are common. Indeed, the appearance of the interior of the nose not infrequently resembles that of neglected tertiary syphilis.

Treatment.—Improvement invariably resulted in Hollman's cases from the use of a 25 per cent. spray of eucalyptus oil in albolene. In the atrophic cases discharge and odor disappeared after the use of eucalyptus spray and rubbing into the parts ichthyol (20 per cent.) in glycerin.

Nasal Myiasis.—Occasionally the larvæ or maggots of the ordinary house fly are found in the nose or ear of individuals with foul discharges. However, their presence is incidental, and not a cause of the disease. As the result of the deposit of the eggs of the screw-worm fly (Campsomyia macellaria) within the nasal chambers of man and the domestic animals, there result severe symptoms often terminating fatally. In America the screw-worm fly is found from the Argentine Republic to Canada, but the greatest amount of damage is done in tropical and subtropical sections. A single fly is capable of depositing hundreds of eggs which hatch in less than twenty-four hours. The worm or maggot reaches maturity in about a week, during which time its ravages in animal tissue are most destructive. It then instinctively abandons its unwilling host and buries itself in the earth during the puparial state, which occupies about fourteen days, and emerges a mature fly.

Symptoms.—The initial symptom is a peculiar sensation at the base of the nose followed by inordinate sneezing and, finally, excruciating pain over the frontal sinuses and the maxillary antra, probably as a result of the penetration of maggots into these cavities. There is a temperature of about 102° F. and in severe cases delirium may be present. Within a few days there is a foul-smelling discharge from the nose, which, however, does not contain maggots until, as already stated, after a week's sojourn in the tissues they instinctively seek the earth to undergo their transformation into mature flies.

On inspection, the interior of the nose may present a necrotic or gangrenous appearance. The soft parts may be destroyed, exposing bone which may become necrosed. The palate is sometimes perforated and swallowing or speaking may be impossible because of swelling or destruction of tissue; fetid odors then sometimes occur and pneumonia may result from inspiration of septic discharges.

Treatment.—Pain is usually sufficient to require morphin. Chloroform is a specific to the extent that the maggots are either killed by its vapors or wriggle from the deeper tissues into a superficial position, whence they are readily removed. The inflamed tissue becomes remarkably tolerant to its local irritation and 25 per cent. in olive oil may be injected two or three times a day.

Foreign Bodies in the Nose.—Children and insane persons occasionally insert into their noses buttons, cherry-stones, beads, beans, twigs, hair-pins, etc. Necrosed bones, when detached, act as foreign bodies and produce their characteristic symptoms. Rhinoliths, ascarides, and maggots are also found in the nose, and may be considered as foreign bodies.

Symptoms.—Obstructed nasal respiration proportionate to the size of the foreign body. If the foreign body is large or causes pressure, headache and pain of a neuralgic character are complained of. At first the presence of a small foreign body in the nose of a child attracts but little attention unless the child tells its parent there is something in its nose. After a time a discharge of glairy mucus occurs, which excoriates the skin of the lips and alæ, but the discharge soon becomes purulent and may be streaked with blood and be fetid. A one-sided discharge from a child's nose is almost pathognomonic of a foreign body, and under such circumstances the most careful and painstaking search should be undertaken to discover the offending particle.

Rhinoliths generally contain as a nucleus a foreign body around which the nasal secretions accumulate and deposit a coating of earthy salts, gradually increasing in thickness. The presence of a rhinolith causes practically the same symptoms as that of a foreign body of similar size and shape.

Treatment.—The foreign body or bodies should be removed by means of a pair of forceps or a blunt ear curet.

Rhinoliths may sometimes be removed whole or may have to be broken up by means of a powerful pair of forceps in order to remove them from the nose.

Neuroses of the Nose. Motor Neurosis.—Twitching of the nose and eyelid is generally due to peripheral irritation of some branch of the facial nerve. It occasionally occurs as the result of the application of the galvanocautery to an anterior hypertrophy.

Paralysis of the dilatores nasi produces a collapse of the lateral walls of the anterior portion of the nose that decidedly interferes with nasal respiration. Unilateral paralysis of the dilator nasi occurring in childhood, according to some of the older writers, is one of the causes of deviation of the nasal septum. The partial stenosis in long thin noses, due to the valvular action of the anterior portion of the sides of the nose by which inspiration is impeded, can be alleviated by cutting a strip of requisite length from a visiting card, bending it, and placing it with its ends up inside the vestibule of the nose in such a manner that it acts as a spring holding the anterior nares open. However, in such cases the valve-like action of the anterior portion of the sides of the nose disappears permanently in many instances by increasing the breathing space by the removal of a small ecchondrosis from the septum or cauterization of the anterior turbinate.

Sensory Neuroses.—*Anosmia*, or loss of the sense of smell, may be congenital or acquired. If acquired, the condition may be due to syphilis, hysteria, or result from lesions of the olfactory bulbs produced by meningitis, tabes, or the pressure of a brain tumor. Disturbances of the sense of smell amounting to almost complete loss occur from any cause that prevents odorous particles reaching the portions of the nose where the peripheral nerve-endings of the olfactory nerves are distributed.

An ordinary cold, hypertrophic rhinitis, or polypi frequently cause mechanically greater or less loss of the sense of smell, which returns after the mechanical obstruction is removed. In atrophic rhinitis affecting the vaults of the nasal chambers there is generally great impairment of the sense of smell, which in some cases is partly restored when crusts and accumulations no longer form. In inflammation of the ethmoid cells, especially in those cases where the middle turbinates are sufficiently swollen to press on the septum, great impairment of the sense of smell is usually present.

Hyperosmia is an increased sensibility of the olfactory apparatus. The ability to detect odors, generally stenches, is intensified. The condition is sometimes observed in nervous women.

Parosmia is a perversion of the sense of smell associated with local or systemic disturbances, insanity, etc. The sensation of a bad odor is sometimes apart of the aura of epilepsy.

Hyperesthesia and *anesthesia* of the nasal mucous membrane are occasionally encountered.

Paresthesia, or the sensation of imaginary stenosis o foreign bodies in the nose, occurs in a certain proportion of neurotics. It is not an unusual thing for such patients to complain of stenosis when the condition present is atrophic rhinitis with widely patulous nasal chambers.

Reflex nasal neuroses are classified according to Jurasz into: 1, Those with the initial point of the reflex circuit within the nose; 2, those in which the initial and end points of the circuit are within the nose; and 3, those in which the end point only is within the nose. To the first class belong asthma, reflex cough, spasm of the pharynx and glottis, and rarely epilepsy, etc. To the second group belong hay-fever and nasal hydrorrhea. The third group consists of cases where there are nasal symptoms or changes as the result of abnormalities of the genital tract. Examples are the violent fits of sneezing produced in some males by sexual excitement, and congestion of the nasal mucous membranes in either sex during the period of courtship, and control of the pain of dysmenorrhea by applications of cocain to the so-called nasal genital spots of Fliess. These are the tuberculum septæ and the anterior portion of the inferior turbinate. In some cases these localities swell, become cyanotic, and are sensitive to the touch of a probe during menstruation. There are spots of great susceptibility to irritants on the lateral wall of the nose above the anterior end of the middle turbinate and on the septum anterior to this locality. In asthmatics, touching one of these spots will sometimes bring on an attack which subsides when cocain is applied. Light cauterization of these irritable spots is sometimes of value in the treatment of cases of nasal dysmenorrhea or asthma.

Sphenopalatine neuralgia sometimes results from toxemia or extension of inflammation from the posterior ethmoid cells, sphenoid antrum, or from the nasal mucous membrane, to the sphenopalatine ganglion. There may be pain in the root of the nose and the eye, in the upper and even lower jaw extending backward to the ear; it is most severe at a point about 2 inches back of the mastoid. The pain may extend downward to the shoulder and even the fingers. There may also be unilateral paresis of the soft palate on the side of the lesion. In some cases there are severe coryza with ocular conjunctivitis and photophobia.

Treatment.—Relief follows applications of cocain to the posterior end of the middle turbinate and adjacent mucous membrane of the pharynx. This may be followed by applications of 2 per cent. silver nitrate. In some cases it is necessary to inject the ganglion in order to affect a cure. Sluder advises that the posterior end of the middle turbinate and nasal wall immediately behind it be transfixed with a long needle which is thrust through the bone to a depth of 0.66 c.c. in a direction upward, backward, and outward. The tip of the needle is now in the pterygomaxillary fossa in which the ganglion lies. A few drops of 2 per cent. phenol in alcohol are now injected. The injection is not entirely devoid of risk, as cases of increased pain, severe secondary hemorrhage, paresis of the abducent nerve, and sciatica have been reported.

Hay-fever, or coryza vasomotoria periodica, is a chronic nasal affection depending upon disturbance of the nervous system, particularly of the nerves supplying the nasal mucous membranes. It is characterized by periodic exacerbations caused by inhaling dust or other irritants.

The *synonyms*—hay-asthma, autumnal catarrh, rose cold, horse cold, cow cold, peach cold, snow cold, miller's asthma—are names given to varieties of the affection and supposed to indicate the irritant which is the direct cause of the attack of the disease.

Etiology.—There are three factors in the causation of an attack of hay-fever, viz.: First, a pathologic condition of the nasal chambers; this may comprise anterior or posterior hypertrophies, exostoses, ethmoiditis; but more especially the presence of hypersensitive areas, distinguished by their heightened color and slight elevation above the surrounding mucous membrane. These generally correspond to the sensitive areas of the nose already described. Irritation of one of these spots with the end of a probe even during the winter time will bring on an attack of hay-fever lasting from an hour to several days; second, a diseased or, at least, an irritable condition of certain nerve-centers, giving rise to a train of near and remote symptoms by reflex action; third, the presence of an external irritant. *The absence of any one of these factors is sufficient to prevent an attack.*

Symptoms of an attack of vasomotor coryza are those of coryza—a sense of dryness and itching in the nose, violent sneezing, occlusion of the nares, and profuse watery discharge. These symptoms are usually followed by conjunctivitis, lacrimation, photophobia, headache—often of a neuralgic character—a hacking cough, asthma, and a general feeling of malaise.

Treatment.—The most effective treatment of periodic hyperesthetic rhinitis is a sea-voyage lasting through the entire hay-fever season or residence in a region free from the presence of irritating pollens and dust, like that of the White Mountains of New Hampshire. (See Climatology.)

For professional and business men, however, such a treatment involves hardships and loss of business opportunities that render it acceptable only as a last resort. Therefore any treatment that will enable the sufferer to remain at home in comparative comfort and attend to business is eagerly sought by the majority of workers suffering from hay-fever.

The neurotic condition of the patient and the hypersensitiveness of the nasal passages is sometimes due to an excess of protein acid in the blood. This excess could be eliminated by the ingestion of mineral acids.

Probably any mineral acid would prove efficacious, but there are two which suggest themselves as peculiarly efficacious: hydrobromic acid, because of its sedative qualities, and nitromuriatic acid, because it is thought to limit the production of uric acid.

Five to ten drops of the freshly prepared concentrated nitromuriatic acid may be given between meals and sometimes also at bedtime. The dose should be diluted with a tumblerful of water, and the patient, after taking the medicine, should rinse out his mouth and swallow another half-tumblerful of water.

When effective, the results of the remedy are apparent within forty-eight hours, and the relief of all hay-fever symptoms is usually sufficient to enable the patient to remain at home and attend to his ordinary business engagements in comparative comfort. If, however, a single dose is omitted, some symptoms of hay-fever will appear within a few hours. This is especially true if the remedy is not taken after the evening meal, as, under such circumstances, the patient usually wakes up the next morning with occluded nares and suffused eyes.

Between the attacks of hay-fever measures should be adopted to improve the patient's general health and correct any abnormality of the interior of his nose. The practitioner, however, should not be too sanguine as to the beneficial results to be obtained by such measures, for it should be borne in mind that hay-fever not infrequently occurs in vigorous individuals the interior of whose noses present no gross abnormality except during the hay-fever season.

There is, however, one condition of the nose that is apparently present in all individuals suffering from hay-fever, and that is the presence of hyperesthetic areas upon the respiratory portion of the nasal mucous membrane, which when touched with a probe cause sneezing and lacrimation.

The hypersensitive condition of such areas may be destroyed one or two at a time, even during the hay-fever season, by cocainizing the nose and touching the sensitive area with chromic acid by means of a cotton-tipped probe, or destroying the sensitive areas by a light touch of a small galvanocautery.

Temporary relief may be obtained during the worst stages of the attack by spraying the nose with an alkaline 1 per cent. solution of cocain, and afterward with fluid vaselin as a protective. It is, of course, justifiable to use cocain during an office treatment, but cocain should not be prescribed for the patient's home use, as hay-fever victims are often, because of the neurotic temperament, most liable to contract the cocain-habit.

As a home treatment the patient may spray the nose every hour or two, if necessary, with a solution of adrenalin hydrochlorate in the strength of 1 : 10,000 or 1 : 20,000. However, in many instances oily preparations are more efficient than watery solutions, and an ointment made up with lanolin and vaselin of a strength of 1 : 10,000 is of decided value. It is conveniently dispensed in collapsible tubes, so that the patient can carry it about in his pocket and squeeze out from the tube from time to time the amount of ointment required. A piece the size of a pea may be inserted into each side of the nose every two hours by a brush or simply with the tip of the little finger. The head is then thrown back until the ointment melts and distributes itself over the nasal mucous membrane. Adrenalin (1 : 1000) in oil may be applied by means of a nebulizer. This form of medication, because of the minute amount of adrenalin actually deposited in the nose, is most successful in the mild cases; but because of the very pronounced reaction from even dilute solutions of adrenalin the ultimate results of the treatment are far from satisfactory.

Dunbar has prepared hay-fever *antitoxin* by the inoculation of horses with the toxins obtained from the albuminoid body found in the starch particles of pollen. The serum obtained from the horse is dispensed either in a liquid or dry form, and is designated to be applied to the mucous membranes of the nose and that of the eyes when required.

The serum has been named *Pollantin*, and two forms are on the market, one prepared from rye pollen, especially used for spring and summer hay-fevers or "rose cold," and the other, prepared from ragweed pollen, designed as a remedy for the hay-fever occurring in the late summer and fall.

Dunbar believes that hay-fever is the result of a specific poison found in pollens, and his antitoxin is designed to immunize patients against pollen toxins when used previous to the hay-fever season, and also to palliate the symptoms in cases where the disease has already made its appearance.

When applied to the inflamed mucous membrane of the nose or eye, pollantin produces a sensation of ease and comfort which persists for some time.

There are apparently two classes of pollen causing hay-fever: one spiculated and poor in protein causes the symptoms by mechanical irritation of the hypersensitive nasal mucous membrane; the other, unspiculated but rich in protein, acts as the result of the absorption of the protein. Rag-weed pollen is an example of the first class; grass pollen of the other. In protein hay-fever a local skin reaction results from vaccinating the skin with an extract of the pollen. Under each circumstance immunization by the injection of pollen extracts is likely to prove of service, but treatment will probably have to be repeated annually.

The use of autogenous vaccines has been employed by Farington and others with about 50 per cent. of cures.

The average number of injections was nine. The dose best suited was found to be 200,000,000 every fourth day. Larger doses were tried in a few instances, but no especial benefit noted.

In several cases where the dose was increased to 400,000,000 or 500,000,000, a rather marked reaction with the increase of hay-fever symptoms occurred, necessitating a skip of six or eight days in the treatment. Improvement may not be expected until three doses have been given. Some cases eventually cured did not show improvement until the sixth dose had been given. Beneficial results have followed injections of staphylococcus vaccines an it is probably the protein both in the pollen extracts and in the vaccines that is the curative agent.

There are a number of drugs which when taken internally are capable of at least mitigating the severity of the local symptoms of hay-fever. The more important are atropin, hyoscyamus, heroin, quinin, monobromate of camphor, strychnin, and, best, chlorid of calcium in doses of 5 grains three times a day.

Nasal hydrorrhea is a disease characterized by a clear watery discharge from one or both nostrils as the result of some irritation or disturbance, either peripheral or central, of the vasomotor supply of the nasal mucous membrane.

Etiology.—In one class of cases the flow of fluid from the nose is perfectly passive and causes no inflammation. The phenomenon is probably due in such cases to a paresis of the nasal branches of the trifacial nerve, which exercises an inhibitory action upon the normal exosmosis of serum in the nasal mucous membrane.

In a second class of cases the flow of serum is accompanied by great congestion and swelling of the schneiderian membrane, and the phenomena are the result of an irritation of the vasomotor nerves. In this second class of cases the congestion and inflammation of the nasal mucous membrane and the consequent watery discharge are greatly increased by cold and by inhaling dust and other irritants. Indeed, the symptoms are somewhat similar to those of hay-fever.

Symptoms.—In the first class of cases there is an almost constant dropping of a clear watery fluid from one or both nostrils. In the second class of cases the discharge is more remittent in character, according to the amount of irritation of the schneiderian membrane.

Treatment.—Richard Lake claims that the blood is the source of trouble in many instances and successfully treated several cases with calcium chlorid 35 to 45 grains a day for two weeks. The rhinorrhea was not only completely relieved, but recurred, if at all, only at long intervals easily remediable by treatment.

Disease of the ethmoid cells (page 180) sometimes produces rhinorrhea which ceases when the ethmoidal condition receives appropriate treatment. In some cases adrenalin acts as a specific. A solution of the strength of 1 : 20,000 up to 1 : 1000 should be sprayed upon the nasal mucous membrane sufficiently often to control the symptoms. From 2 to 5 gr. of the extract of suprarenal capsule also should be taken every three hours, the patient being instructed to cease taking the remedy should disagreeable heart symptoms manifest themselves. In some cases a cessation of the discharge occurs within a few days, and the use of the remedy should then be discontinued.

Sometimes astringents applied locally answer a useful purpose, and an ointment of gallic acid (10 gr. to the ounce of vaselin with 1 or 2 gr. of menthol) may be prescribed with benefit.

Cerebrospinal rhinorrhea is a discharge of cerebrospinal fluid through the nose and should be carefully differentiated from nasal hydrorrhea which is simply a discharge from the nasal mucous membrane. The amount of cerebrospinal fluid discharged in twenty-four hours may reach 12 to 16 ounces.

The diagnosis of such cases rests upon an analysis of the fluid. Normal cerebrospinal fluid is transparent and colorless and may deposit cells from the cerebrospinal cavity. It is alkaline, with a faint reaction for sodium chlorid. Heat and nitric acid yield no deposit, but on cooling a slight white cloudiness indicates the presence of albumose. It usually reacts with an orange-red deposit to Fehling's test. The prognosis as to cessation of the discharge is not good, yet patients have lived for many years without fatal infection of the meninges, but about 75 per cent. of the cases reported suffered from optic neuritis, atrophy, or hemiopia. No treatment is effective, but headache, drowsiness, and other cerebral symptoms improve when the flow is free. Occasionally the discharge ceases abruptly.

Nasal Hemorrhage.—*Etiology.*—It is an old saying that recurrent hemorrhage from the nose may be a warning, a remedy, or a disease.

The bleeding may be the result of some disease of the blood, of which the most common are plethora, purpura, hemophilia, and the condition of the blood brought about by typhoid and the eruptive fevers. Diseases of the blood-vessels, the result of atheroma or syphilis, are predisposing causes, while the increased blood-pressure resulting from Bright's disease and organic disease of the liver, heart, lungs, or kidneys are frequently early manifested by bleeding from the nose.

No good observer probably has failed to be impressed with the very evident correlation existing in most of our domestic animals between the nose and the sexual organs exhibited during the rutting season. Similar phenomena occasionally are observed in the human race, and many amusing stories are told in illustration.

Erectile tissue occurs in but three portions of the human body: the nose and throat, the nipples, and the sexual organs. In the male, puberty is accompanied by a change of voice, and nosebleed is not uncommon at this time in either sex; in the female, sometimes as a vicarious menstruation. Recurrent nosebleed is said to be aggravated by masturbation.

Ulcerations and neoplastic growths within the nose are sometimes hemorrhagic. Angiomata, carcinomata, sarcomata, and especially fibromata frequently bleed at the slightest touch. Severe and repeated nasal hemorrhage, when it occurs in a youth with a nasopharyngeal tumor, is almost diagnostic of fibroma.

Traumatism is a frequent cause of hemorrhagia narium. If the blood flows from each side of the nose in equal amounts, it is somewhat suggestive of injury to the vault of the pharynx or even fracture of the base of the skull, because hemorrhage from injury to the nose alone is usually unilateral. However, blood from the nose may be swallowed or drawn into the bronchi and afterward coughed up or vomited in a manner suggestive of a pneumonic or stomachic origin of the hemorrhage. It is not always easy to make a diagnosis between bleeding from the vault of the pharynx and hemoptysis.

The nasal vessels are not supported by a muscular cushion into which they may be crushed by a blow, but lie in more or less intimate contact with bone or cartilage, and are only protected by extremely delicate mucous membrane, and hence a slight injury is sufficient to cause hemorrhage, which is profuse and long continued because the proximity of bone or cartilage prevents the ends of the severed vessels from contracting as readily as if they were embedded in soft tissue. When sawing exostoses from the septum an artery within the bone is occasionally encountered, and because the end of the vessel is held wide open by its attachments to the bone, hemorrhage is invariably profuse and long continued. Such cases require radical measures to control the flow. Fortunately, however, arteries within such growths are comparatively rare. Since the use of adrenalin solutions before nasal operations it is said that secondary hemorrhages after nasal operations are more common. The usefulness of this drug has its limitations. Its effects only penetrate a certain depth into the tissues and it, of course, has no effect on a vessel deeply embedded in bone. The reaction after its use as a therapeutic agent to control congestion is much greater than that of cocain, and therefore it must be used for this purpose only in dilute solutions.

The *prognosis* of all forms of nasal hemorrhage is generally favorable, but few fatal cases having been reported.

Pathology.—The great vascularity of the nasal mucous membrane readily explains the great frequency of nasal hemorrhage. In most cases of spontaneous origin the bleeding is from the neighborhood of the septal artery—*i.e.*, from the anterior part of the septum. Wounds resulting from surgical operations upon this portion of the nose frequently bleed profusely, although an artery is sometimes observed to "spurt" in the wound of an operation done further back upon the septum, while spontaneous bleeding may occur from posterior hypertrophies or adenoid vegetations. In such cases the blood flowing downward into the fauces is expectorated and is frequently mistaken for a hemorrhage from the lungs.

Treatment.—If after an operation severe hemorrhage has occurred, and it is known from what spot the bleeding occurs, a small mass of absorbent cotton or "Bernays' sponge" (Fig. 51) should be placed within the nose over the bleeding vessel.

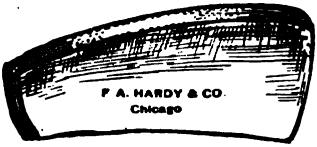

Fig. 51.—Simpson's intranasal tampon shaped from "Bernays' sponge" or compressed cotton. When inserted within the nose, the cotton rapidly absorbs moisture and swells to many times its original thickness, thus exerting sufficient lateral pressure to control nasal hemorrhage. In wide noses two or even three tampons may be inserted side by side, although this is seldom necessary to control hemorrhage. If too large, the tampon may be cut into the required shape with scissors. Strips of Bernays' sponge about 3 inches long and 12, 14, or 16 mm. wide are often more convenient than Simpson's tampons.

Bleeding may occur from any portion of the nose, but it is most common from the anterior portions of the septum. In cases of recurrent nosebleed, after an attack, a small clot, a yellow spot, or a varicose condition of the veins upon the septum will mark the seat of the hemorrhage. Under such circumstances the patient should be directed to apply daily, by means of a brush, an ointment of gallic acid (10 gr. to an ounce of vaselin), and to avoid violently blowing the nose. Should the vessels be very numerous and varicose, this treatment will hardly suffice, and it will be necessary to destroy the vessels by a touch of the galvanocutery or chromic acid. It is not well to apply the galvanocautery or chromic acid too vigorously, as the cartilage of the septum has not much vitality, and too vigorous application of either caustic may result in perforation. Simply singe the *mucous membrane* lightly with the flat side of a small cautery-knife. A whitish spot upon the mucous membrane and the disappearance of the outline of the vessel indicates that the burn will be effective.

Occasionally recurrent nosebleed is the result of a small ulceration or erosion of the mucous membrane of the anterior portion of the septum, generally in a hollow caused by a slight deviation of the septum or a cartilaginous spur within the nose. Because of the hollow upon the septal wall, mucus dries until the bulk becomes sufficient to extend above the hollow into the air-current, when it is dislodged by violently blowing the nose or by sneezing. Under such circumstances a minute portion of mucous membrane is carried away with the inspissated mucus and hemorrhage occurs. Sometimes the hemorrhage occurs from dislodging such masses of mucus with the finger-nail. The patient should be cautioned against picking his nose, as under such circumstances the resulting ulceration becomes deeper, until finally it extends entirely through the septum and a perforation results.

Generally the formation of crusts and scabs can be prevented by frequent applications of carbolized vaselin, but should this not suffice, the hollow in the septum must be eradicated by suitable operative procedure. The usually slight bleeding from anterior ulcerations, as it occurs from time to time, can be controlled by grasping the tip of the nose firmly between the thumb and finger, the insertion of a small piece of ice within the naris, by applying an ointment of adrenalin on absorbent cotton, or by inserting a Simpson tampon which when saturated with blood swells to the original bulk of the cotton before it was compressed (Fig. 51).

In most cases such remedies as adrenalin are useless, because the flow of blood prevents their coming into contact with the mucous membrane and exerting their effects; nor is it possible, in most instances, to accurately locate the bleeding spot and apply pressure to it directly. Usually the patient is found bending over a bowl upon his lap or he may be resting upon the bed in such a position that his head leans over its side so as to allow the blood to drip into a receptacle upon the floor. Have him at once sit erect, with his head neither thrown back nor forward, and instruct him to hold a finger-bowl under his *chin* (not nose) to catch the flow of blood.

This change of position takes off pressure from the veins in the neck and may be all that is necessary to stop the hemorrhage. If this be the case, a little pledget of absorbent cotton, saturated with vaselin, should be inserted loosely within the naris to support the clot and prevent the patient from breathing through that side of the nose.

If in spite of the change of the patient's posture the blood should continue to flow, it will be necessary to apply pressure to the bleeding vessel. This is most expeditiously, painlessly, and effectually accomplished by inserting a Simpson tampon into the nose, which usually controls the bleeding as soon as the cotton is saturated with blood. In cases where the bleeding spot is far back in the nose, it is better to insert a strip of Bernays' sponge (Fig. 51) ½ inch wide and about 2½ inches long through the inferior meatus into the nasopharynx, and cut off with stout scissors any redundant portion projecting from the anterior naris. Such a strip when saturated with blood will completely occlude both the posterior and anterior nares. When Bernays' sponge is not available the bleeding may be controlled by adding hydrogen peroxid to the clot within the nose, which causes an increase of many times its original bulk. Wrap a piece of absorbent cotton loosely about an Allen probe so that it forms a cone 3 inches in length and 1 inch in diameter at its proximal extremity (Fig. 52). Thrust this dripping with hydrogen peroxid along the floor of the nose until the pharynx is reached. Place the forefinger-tip against the cotton within the nose and withdraw the probe, leaving the cotton in position supported by the finger-tip until the pressure caused by the ebullition of gas has somewhat subsided, then withdraw the finger and support the first pledget by means of a second plug of cotton saturated with hydrogen peroxid. This is pressed firmly into the naris, especial care being taken that it firmly fills the space within the extreme tip of the nose, or blood will escape over the cotton plug. If required, a third or even a fourth plug of cotton may be used.

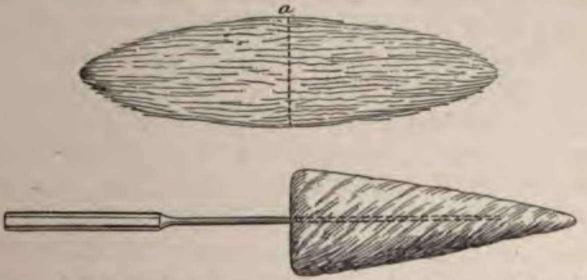

Fig. 52.—Method of making pressure-cone of cotton for the control of nasal hemorrhage. A piece of absorbent cotton (*a*) is frayed at each end into a thin edge, folded through the middle (dotted line *a*), and loosely wrapped about a nasal applicator in such a manner as to form a cone. This is dipped into hydrogen peroxid and placed within the nose.

It is well to smear the whole of the presenting surface of the cotton with a solution of perchlorid of iron, which dries with a little blood into a black impenetrable varnish, and allows no blood to trickle. Never apply any of the iron salts *inside* the nose to control hemorrhage, as they are extremely irritating and form a sort of sticky black sand difficult to remove.

This method of controlling nasal hemorrhage is much less irritating than most others employed; but at the end of five or six hours swelling of the mucous membrane will have occurred to a sufficient degree to render the packing within the nose somewhat uncomfortable, and it is generally advisable and safe to remove the outer plug. This should be done with extreme gentleness, avoiding any sudden pull or jerk. At the end of twelve or twenty-four hours the larger mass of cotton can often be removed with safety if done in a proper manner. Avoid removing pressure too suddenly or the hemorrhage may recur, and then the packing will have to be replaced. It is well to have at hand a smaller cone of cotton saturated with peroxid to instantly replace that removed should this accident occur. Grasp the end of the mass of cotton to be removed with a pair of dressing-forceps and draw it forward $\frac{1}{8}$ inch, then wait five minutes. Repeat this procedure at intervals of five minutes until the mass is coaxed, as it were, from the nose. If, during this process, a drop of blood shows itself, cut off with a pair of bandage-scissors that portion of the cotton already outside the nose and press into the vestibule a little mass of fresh cotton saturated with peroxid. Be content to wait for an hour or so before trying to remove the packing; for, at any rate, you have diminished the pressure within the nose and rendered your patient more comfortable. If, however, you have succeeded in removing the whole of the cotton without the hemorrhage recurring, place a little cotton in the vestibule of the naris and allow your patient to rest for a half-hour or so before permitting him to blow out the clot—which should be done with great gentleness. It is advisable in all cases to remove the packing from the nose at the end of forty-eight hours, as by that time it will be extremely foul smelling and there is danger of sepsis. If necessary to check the recurrent hemorrhage, the nose can be packed again with cotton saturated either with peroxid or alboline, which, next to peroxid, is probably the best hemostatic for use within the nose.

In most works on surgery an instrument called Bellocq's cannula is figured, by means of which the posterior nares may be plugged by drawing a mass of gauze through the mouth behind the soft palate; if at hand, this instrument may be used. A simpler plan is to insert a eustachian catheter through the nose and pass a catgut suture, string, or well-waxed piece of stiff silk or linen suture through it until its end appears in the fauces, when it may be seized by a pair of forceps and drawn out through the mouth. A piece of iodoform gauze should then be tied to the middle of the catgut string or waxed cord, and drawn up behind the palate into the vault of the pharynx in such a manner that one end of the string projects from the nose and the other from the mouth. The ends of the suture material may now be tied together, so that the plug is firmly held in position. If a eustachian catheter is not available, a silk suture may be tied around the eyelet of an ordinary soft-rubber urethral catheter, which is then passed through the inferior nasal chamber until the suture and catheter appear in the pharynx. However, plugging the posterior nares is seldom, if ever, necessary to check hemorrhage from the nose, but may be used where ether is administered to prevent blood flowing into the pharynx during an operation upon the interior of the nose.

Clotting and consequent cessation of the hemorrhage is sometimes hastened by injecting warm liquid gelatin into the nose.

In hemophilia or purpura, after the nose has been packed with absorbent cotton and peroxid, calcium chlorid or lactate (Formula 47), 5 to 10 gr. every two hours, may be given in capsule or dissolved in a little water. Emetin has been used either as a prophylactic or as a remedy in nasal hemorrhage. It has been established that clotting takes place through the action of thrombin or fibrinogen, the origin of the thrombin, however, being still a subject of controversy; normally clotting is prevented in the blood by antithrombin which is supposed to be formed in the liver. The liver plays an important part in coagulation, providing the intestines and adrenals with the necessary elements to hasten clotting after extensive bleeding. Human blood or horse-serum by supplying "fibrin ferment" to the patient's blood sometimes quickly controls hemorrhage in these cases. From 10 to 30 c.c. should be injected subcutaneously. Coagulose or desiccated serum dissolved in normal salt solution may be used in the same manner as the fresh serum.

TUMORS

Nasal Polypus.—The most common growths to be found within the nose are mucous polypus, fibroma, or fibrous polypus, cyst, ecchondroma, exostosis, osteoma, papilloma, angioma, sarcoma, and carcinoma.

Fibrous polypi differ from the soft or mucous polypi simply because of the proportion of fibrous material each contains.

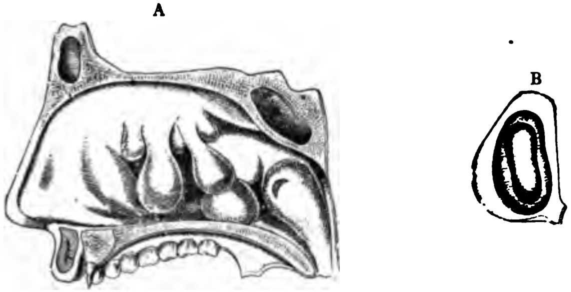

Fig. 53.—A, Mucous polypi in the nose; B, anterior view of same, normal size (Sajous).

Instead of being soft, gelatinous, and highly hydrometric, fibrous polypi are hard and fibrous. They usually have their attachment in the upper posterior portion of the nasal chambers, but sometimes within the antrum. When attached to the junction of the nose and pharynx the fibrous tissue is so abundant that the resulting tumor is a true fibroma almost as hard as bone. Nasopharyngeal fibromata are extremely vascular, bleeding sometimes at the slightest touch. Fibrous polypi are probably local hypertrophies of the mucous membrane and submucous tissues that have undergone fibrous change in proportion to the amount of connective tissue involved.

Mucous polypi most frequently originate from the middle turbinated region of the nose. Here the mucous membrane possesses low folds. It is thin, the subepithelial tissue loose and abundant, and the erectile tissues scanty. The mucous glands on the lateral surface of the middle turbinates are numerous.

As the result of chronic inflammation from any cause the normal folds of the mucous membrane become edematous. This edema is favored by the dependent position of the parts until it is sufficient to develop into mucous polypi. The normal active glands of the middle turbinated region prevent the occurrence of edema, but when the glands cease to act as the result of degenerative changes, edema results.

Etiology.—Any long-continued irritation of the nasal mucous membrane may result in polypi. The non-suppurative, hyperplastic form of ethmoiditis is the usual cause of polypi. There are many cases of sinus suppuration without polypi, so that it is probable that suppuration of the accessory sinuses is more often the result than the cause of polypus.

Treatment.—Removal of the nasal polypi and adequate treatment of the cause that produced them, in the manner described in the sections upon Ethmoiditis and Hypertrophic Rhinitis. The mere removal of the polypi is usually only the first step toward bringing about a cure of the nasal disease. Simple removal is usually followed by a relapse into the former condition. Therefore after the removal of the growth the surgeon should not be content until the parts from which they grew have firmly cicatrized.

Operations.—The nasal chamber is cocainized with a pledget of cotton saturated with a 3 per cent. solution of cocain, and the parts sprayed with a 1 : 5000 solution of adrenalin. The operative speculum (Fig. 17) is then inserted into the nostril and the size and attachment of the most anterior of the polypi determined by a probe and by pulling it forward with forceps. The loop of a snare (Fig.

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42) is then slipped over the polyp and manipulated until the loop encircles its base, the loop quickly tightened, and the polyp severed from its attachment by a little jerk. The parts are again sprayed with adrenalin and the next polyp removed by the snare, and so on until the nasal chamber is completely free from the growths.

Spraying with adrenalin solution after the removal of each polyp usually prevents excessive hemorrhage and secures a satisfactory view of the middle turbinate region from which they grow. Should the inferior border of the turbinate be covered by stumps of polypi that have escaped the snare, it is better to remove this diseased tissue at once with a swivel-knife to prevent a return of the growths.

There is no after-treatment except that the patient should cleanse the nasal chambers by spraying with Dobell's solution or some similar alkaline wash. The surgeon should inspect the surfaces from which polypi have been removed at sufficiently frequent intervals for about six months and remove small polypi ("buds") or any suspicious spot upon the middle turbinate with a swivel-knife or punch forceps in order to secure a firm cicatrix. However, when instead of multiple polypi the contents of a nasal chamber consists of a single large polypus, its removal is ordinarily followed by cure without further treatment.

Nasal cyst usually occurs as a large sessile bladder, filled with a thin, watery, mucous fluid, attached to the inferior turbinated bone.

Nasopharyngeal fibromata consist of fibrous tissue containing numerous large blood-vessels which when severed bleed profusely because of the hardness of the tissue in which they are embedded. These growths usually originate from the thick, fibrous aponeurosis covering the basilar process, but sometimes a pedicle extends from one of the accessory sinuses, especially the maxillary. They often hang down from the vault of the pharynx so as to be plainly visible through the mouth, and may send prolongations into the nose and all of the adjacent cavities, either bending around obstacles or eroding their way through them, enlarging the nasal chambers, thinning the bones, and broadening the bridge of the nose as they grow, causing great deformity or what is sometimes called "frog face." Such tumors cannot readily be removed by an ordinary snare. The best imported steel piano wire usually snaps during the attempt, or the snare may be twisted into a cork-screw shape if an attempt is made to tighten the wire by turning the screw of the instrument with a wrench. The growth is, however, readily removed by means of a galvanocautery snare with its red-hot wire. Relapses are common, although the disease generally attacks children; and there is a distinct tendency toward slower growth of the tumor or even retrograde changes as the individual advances in years.

When the galvanocautery snare cannot be used, a pointed cautery-knife (Fig. 45) may be pushed through the tumor toward the center of the growth and heated while *in situ*. The current of electricity should be turned off as soon as the patient complains greatly of the heat, and after an interval turned on again. This may be repeated several times before the cautery-knife is finally withdrawn from the growth, which should be done with gentleness and care while the current is turned on in order to avoid hemorrhage. The procedure is less painful than electrolysis and results in a greater amount of shrinking of the growth.

Radical operations for the removal of nasopharyngeal fibromata with the knife have been successfully performed, but the fatalities have been somewhat numerous.

Nasal papillomata are wart-like growths most frequently attached to the septum or inferior turbinated bodies. They are generally abundantly supplied with capillaries and some of them bleed at the slightest touch.

Treatment.—They should be removed with the snare and the place of their implantation touched with the galvanocautery to prevent a recurrence.

Nasal Sarcoma.—Sarcoma within the nose presents the same pathologic characteristics as when present elsewhere. It may occur as a primary growth or result from the degeneration of fibrous polypi or papillomata. Nasal sarcomata are generally sessile and of a light reddish color. In children they grow very rapidly and are prone to ulcerate, with the result of producing a fetid greenish or bloody discharge. Penetrating the surrounding cavities and structures, great deformity of the face often results. If growths occur in an upward and backward direction, tinnitus, deafness, and severe pain are usually present, while death may occur from final involvement of the brain by the disease.

Prognosis.—In children the growth ordinarily occurs so rapidly that an early fatal issue is to be expected, while in adults a slower growth makes early and complete evulsion practicable. The tumor will return with increased malignancy if imperfectly removed, but some varieties are more amenable to treatment with radium and the *x*-ray than most kinds of carcinoma.

Nasal Carcinoma.—Carcinoma of the nose is of rare occurrence as a primary affection, but may invade the nasal cavities from surrounding parts. It is usually of the epitheliomatous or encephaloid type.

Treatment.—The varieties of sarcomata and carcinomata differ greatly in their malignancy. Nearly all recur after the most complete operation, while apparent spontaneous cures have been reported. Radium or *x*-ray in many cases at least retards the progress of the disease and should always be employed after an operation *before* recurrence occurs. Even when the antrum is involved, the complete removal of the upper jaw is rarely necessary as access to the growth is readily obtained by the Jansen operation supplemented by an incision along the side and beneath the nose and through the center of the lip, so that a greater exposure of the field of operation is obtained when the flap is dissected back.

DISEASES OF THE NASAL SEPTUM

Deviation.—Normally, the septum is vertical, but after the seventh year deviations generally toward the left are somewhat frequent. Such deviations from the vertical only are considered pathologic when they interfere decidedly with nasal respiration or, by pressure upon the middle turbinated body, cause pain or disease.

Etiology.—Traumatism is the most common cause of the *pathologic deviations*, the most frequent traumatism being a dislocation of the triangular cartilage and the anterior portion of the vomer from each other and their attachment to the nasal crests of the superior maxillaries. Under such circumstances the deviation is of the so-called angular variety, because the dislocated horizontal edge of the septum projects into the obstructed nares as a sharp edge or ridge running back as far as the dislocation extends. The dislocation rarely involves the whole septum, because the posterior portion of the septum is defended from the effects of traumatism by bony walls. Rarely is more than the anterior third of the septum involved in a deviation, and it is, therefore, more exact to speak of a deflected area of a septum rather than a deviated septum.

Between the edges of the dislocated bones and cartilage "provisional callus" is thrown out, which finally unites the separated edges with a firm bony or cartilaginous union, usually thicker than the normal septum, and hence the so-called "hypertrophied angle" of a septal deviation. It will be seen that after the organization of the "provisional callus" the septum has notably increased in size, is redundant or too large to occupy a vertical position within the nose.

According to the extent posteriorly of the dislocation of the septum from the superior maxillary may the deviation be described as vertical or horizontal. In comparatively rare cases a vertical deviation of the septum will involve so little of the septum anteroposteriorly as scarcely to admit the blunt end of a lead-pencil into the deflected area at the base of the septum. Such a deflection probably would result from a very rapid and violent bending of the tip of the nose to one side.

Probably the larger number of deviations, so slight as not to be considered pathologic, are the result of a faulty development of the bones of the face. It is stated that adenoids and other causes of defective nasal respiration cause an arching of the palate, and the septum, crushed between this abnormally narrow arching of the palate and the nasal bones, is bent out of the median position.

As a matter of fact, a comparatively large proportion of deflected septa are encountered, associated with a narrow arch of the palate, and the deviation is due to incoördination in the development of the bones of the face, including those of the nose, and evidently not traumatic. Such deviations are curvilinear instead of angular, sometimes S shaped, and there is usually little or no thickening of the sutural lines. However, they rarely, if ever, involve the whole septum.

By artificially occluding one side of the nose of puppies and other young animals Ziem proved that under such circumstances the occluded nostril and adjacent bones and accessory cavities remained undeveloped.

Asymmetric development of the two sides of the face, if it involved the nasal septum, would result in the bowing or deviation of the septum toward the larger side of the face, because the concave surface of a deviated septum is, of course, smaller than the convex surface.

Pathology.—Septal deviations occur in almost endless variety. A simple classification is physiologic and pathologic, angular, with or without hypertrophied tissue at the angle, round and S shaped, vertical, and horizontal.

Symptoms.—There is sometimes some deformity of the external nose, the tip of the nose being turned to one side of the bridge flattened. The degree of obstruction in the narrowed nostril is in proportion to the deviation of the septum and may amount to occlusion. Usually in such cases there is complete obstruction to inspiration from a valve-like action of the ala of the affected side, while expiration is somewhat free as the result of the blowing outward of the ala by the expired air. Nasopharyngeal catarrh is usually present and is the direct result of the deviation. It will be observed that during inspiration a partial vacuum occurs posterior to the obstruction, and consequent vacuum congestion, that is, the decreased atmospheric pressure behind the obstruction, engorges the blood-vessels of the mucous membrane by a species of suction. The vacuum congestion and consequent catarrhal inflammation frequently extend backward to the nasopharynx. Vacuum congestion also occurs within the dilated portion of the unobstructed nostril, and when chronic catarrh of the middle ear results, it is often the ear upon the side of the unobstructed nostril that first is affected. It might be objected to this mechanical theory of the causation of vacuum congestion back of a deflected area upon the septum that any partial vacuum resulting during inspiration would be counteracted by increased pressure during expiration. That this is not the case is due to the fact that expiration is more deliberate and passive than inspiration and the valve-like action of the ala referred to above.

The amount of obstruction to nasal respiration resulting from a deflected septum is precisely the same as if the obstruction resulted from an exostosis. When the obstruction is complete from inspiration the individual loses one-half his nasal breathing space; for what breathing space is lost in one nostril is not compensated for by increased breathing space in the other, because the unobstructed nostril is not larger, either anterior or posterior to the obstruction, and hence will not transmit more air than if the septum were not deflected.

In the dilated area of the unobstructed nostril the inferior and sometimes the middle turbinated bodies are frequently hypertrophied, probably as the result of the increased blood supply resulting from the decreased atmospheric pressure in the dilated area referred to above. As the result of such hypertrophy the breathing space within the dilated area may be reduced to normal limits. In the obstructed nostril the tubinated body may become atrophied from the pressure of the deflected septum. Should the deflection be so located as to cause pressure upon the middle turbinated body, pain and nasal reflexes are usually present, and sometimes disease of the ethmoid and frontal sinus.

Operations for Correction of Deviation of the Nasal Septum.

Bosworth's Operation.—The simplest operation is that introduced by Bosworth—the removal of the hypertrophied angle of the deviation with a saw. The operation is successful to the extent that it secures increased breathing space in the obstructed nostril.

Gleason's Operation.—The writer's method of operating for deflection of nasal septum is as follows: A U-shaped incision is made around the deviated area, which then becomes a quadrilateral flap, covering a hole in the septum; a sort of trap-door with a spring hinge holding it in a deviated position. This quadrilateral flap is then, with the finger-tip, pushed through the hole in the septum which it covers, and its neck is bent at the same time at a right angle. The *success of the operation depends almost entirely on a thorough bending of the flap.* If the deviated area is of the horizontal type and extends far back along the septum the neck of the quadrilateral flap will contain a considerable amount of bone. When the neck of the flap is bent at a right angle this bone will be fractured with a snap, often audible at a considerable distance. The resiliency of the bony portion of the flap is then as *completely* destroyed as if a submucous resection had been performed because fractured bone remains in the position in which it is placed. As a matter of fact it, to a certain extent, acts as a splint to retain the cartilaginous portion in a vertical plane, as it is impossible to fracture it even by bending to a right angle.

After the thorough bending of the flap it should hang in the formerly unobstructed naris without resiliency; and either Allen's tube or the writer's modification of the same should be dropped into the formerly obstructed nostril. The tube should always fit *loosely*. Any great amount of pressure exerted by the tube becomes well-nigh intolerable within twenty-four hours. The tube serves to control the usually trifling hemorrhage. It is worn over night and the next day it is decided if its support is longer necessary. In rather more than 80 per cent. of cases of deviation of the nasal septum operated upon by the method described above no support whatever was necessary.

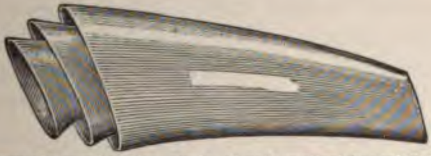


Fig. 54.—Gleason's nasal tubes, made of soft malleable metal (pewter). These tubes may be readily cut with a penknife to any desired length, and their shape considerably altered by bending and burnishing the edges.

In *submucous resection* the cartilage and bone of the entire deviated area is removed, the mucoperiosteum of both sides of the septum being preserved.

The septum is probably best cocainized in the manner described on page 564. The parts are exposed by means of a wire speculum (Figs. 16 or 17), and if vibrissæ interfere with a clear view of the parts, they are removed with scissors. An incision is made through the mucous membrane and periosteum to the septal cartilage at the junction of the skin and mucous membrane by means of a sharp-pointed knife (Fig. 55). The incision should commence high up upon the septum and extend downward partly across the floor of the nose. It is best made on the convex side of the septum, but most operators, unless ambidextrous, almost invariably make the primary incision on the left side of the septum. Freer in certain cases also makes an incision extending backward from this vertical or Killian incision.

The tip of Freer's blunt elevator used as a curet is used to start the separation of the perichondrium from the cartilage and permit the introduction of the blunt elevator between the perichondrium and cartilage, which is gently pushed forward in the line of least resistance, which is usually upward and backward. The tip of the elevator is now moved downward with short strokes and occasional partial rotations, backward and forward, on its long axis until, if possible, the perichondrium is separated from the cartilage well down into the floor of the nose. However, in most cases difficulties are encountered in the region of Jacobson's organ where the perichondrium is closely adherent and also at the suture between the triangular cartilage and the vomer as the perichondrium extends through the suture; and it is necessary to cut it with the sharp elevator (Fig. 56). In some instances it is better to elevate the perichondrium down to the suture and then introduce the elevator at the floor of the nose and separate the periosteum from the bone from below upward.

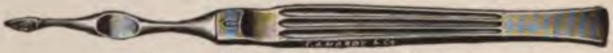


Fig. 55.—Ballenger's septum knife.

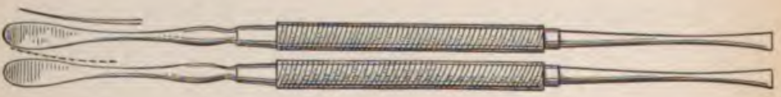


Fig. 56.—Freer's sharp and blunt elevators.

The perichondrium and periosteum having been separated from the left side of the septum over the deviated area, the operator's left forefinger is introduced into the patient's right nostril and the septal cartilage pressed over until it bulges into the left nostril. An incision is made with the point of the knife through the cartilage, but not through the mucous membrane of the right side of the nose, which is felt to ride over the knife point as the incision is made. The posterior cut edge of the cartilage bulges into the left nostril from the pressure of the finger in the right nostril and the blunt elevator is inserted getween it and the perichondrium, which is elevated in the same manner as that of the left side.

If there is any great difficulty experienced in denuding the cartilage it is probably because the operator is inadvertently trying to separate the mucous membrane from the perichondrium, a matter of considerable difficulty, and this mistake should be corrected.

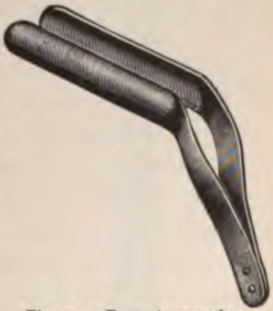


Fig. 57.—Foster's speculum.

If it is found impossible to denude the septum without making large tears in the mucous membrane, the operator should abandon the attempt and do a Gleason operation. This will not interfere with a secondary submucous resection at some future time.

The septal cartilage being cleared on both sides, and its perichondrium held out of the way with a long-bladed speculum (Fig. 57), is readily removed in one large piece by the swivel knife (Fig. 58), or clipped away piece by piece with alligator forceps (Fig. 75). Up to this point the operation has been nearly painless and should not occupy more than five or ten minutes. However, when there is an additional bony deformity, that portion of the perpendicular plate involved should be cut away with forceps. The attachment of the vomer to the anterior nasal spine is now cut through with a chisel or clipped with forceps, and any deviated area of the anterior portion of the vomer removed in the same manner.

No after-treatment is ordinarily required except a Simpson's intranasal tampon, Fig. 51, worn in each nostril over night to hold the two raw surfaces of mucoperiosteum together and prevent the accumulation of blood between them.

Contra-indications and Dangers of Submucous Resection. — The operation should not be done on children under fourteen years of age, in the aged, and when an acute disease of the nose, throat, or ear is present. According to one author, of 31 children ranging in age from six to fourteen years, the operation was followed by broadening of the nose with "saddle-backs" in 6, or 33 per cent. The disaster was accounted for by the contraction of cicatricial tissue. The operation in some cases interferes with the subsequent growth and development of the nose. "Saddle-back" deformity sometimes follows the operation in adults, and is the result of inflammation or dislocation of the upper edge of the septum where it lies wedged in between the two lateral cartilages. Only that portion of cartilage which interferes with respiration and drainage should be removed and at least $\frac{1}{4}$ inch of septal cartilage should be allowed to remain at the roof of the nose, and only such punch forceps used in

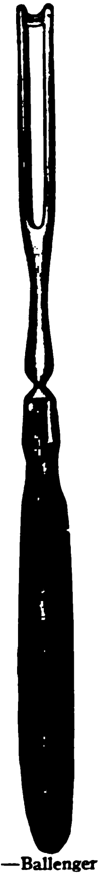


Fig. 58.—Ballenger's swivel knife. There are several sizes of this instrument. It is convenient for the removal of the septal cartilage and many other purposes because its movable blade may be made to cut either upward or downward, backward or forward.

this locality as remove a definite amount of tissue without traction upon the remainder. The same is true when removing the bone of the vertical process of the ethmoid. When death from meningitis follows a submucous resection the infection is usually along the sheath of the olfactory nerves, so that all rough surgery and even unnecessary handling of the periosteum of the upper portion of the septum should be avoided. It is probable that suppuration of the ethmoid cells adds to the risk of a submucous resection, but the author has done the operation a number of times under these circumstances without infection occurring.

A simple tear of the mucoperiosteum usually heals without incident; but if the mucoperiosteums of each side of the septum are torn in such a manner that the tears are opposite each other, and especially if a portion has been torn away, a permanent perforation results. If situated far back upon the septum such perforations produce no symptoms; when situated at the anterior portion of the septum they sometimes produce a whistling respiration, nosebleed, and frequently grow larger from year to year (see page 141).

Occasionally a hematoma forms within the wound. Under such circumstances the lips of the wound should be gently separated and a sterile probe inserted beyond the limits of the collection of blood sufficiently to secure drainage. Should suppuration occur, simply opening the pus cavity by separating the lips of the wound is sometimes sufficient to secure prompt healing if the infection is at the base of the septum. When, however, the suppuration occurs in the region of the perpendicular plate of the ethmoid, it is best to provide ample drainage by wide incisions through the mucoperiosteum of the nose, and the parts should be dressed daily until healing is complete. The pus cavity can be emptied either by syringing with a long nozzled syringe (Fig. 28) or by the use of suction, as in the tr ment of suppuration of the accessory sinuses (page 1

Congenital Occlusion of the Nares.—Congenital occlusion of either the anterior or posterior nares, usually unilateral, is a somewhat rare condition. When the posterior nares are occluded, generally it is the result of a bony outgrowth from the floor of the nose. The anterior naris may be occluded as the result of faulty development or adhesions during embryonic life.

Symptoms.—The symptoms are those of occlusion from any other cause. When the occlusion is posterior there is a discharge of mucus from the nose upon the lip and the patient is unable to cleanse the nostril by blowing the nose. Aural symptoms are sometimes present when the obstruction is anterior.

Diagnosis is made by inspection. Anterior obstructions are readily seen, and those which are posterior may be observed in the rhinoscopic mirror. A rough estimate of the thickness of a posterior obstruction can be made with an Allen probe, the end of which is wrapped with cotton and saturated with a 4 per cent. solution of cocain. This is introduced into the obstructed naris until the obstruction is reached, and the distance compared with that to the posterior edge of the septum on the unobstructed side.

Anterior obstructions are usually thin and web-like. Posterior obstructions usually have a thickness of not over $\frac{1}{4}$ inch.

Treatment.—It is comparatively easy to break down nasal obstructions, either anteriorly or posteriorly; but as they almost invariably recur unless prevented from doing so by a somewhat tedious after-treatment, the wisdom of operating in young children unless very docile is worth considering. When only one side is affected and causes but little inconvenience, the operation in young children should be postponed until the child has arrived at an age to appreciate the advantage to be derived from the after-treatment.

Anterior obstructions are excised with a knife or scissors d a pewter tube (Fig. 54) of suitable size and shape inserted. This is removed and cleansed daily after the operation until the parts have completely cicatrized.

Posterior bony obstructions are removed with the guarded electric drill or burr (Fig. 49), either under ether or, as the operation is not very painful, under cocain anesthesia. If ether is employed, the tip of the forefinger of the operator's left hand is inserted into the posterior naris from the pharynx, to serve as a guide to the parts to be removed by the drill and to prevent injury to the surrounding structures.

The after-treatment consists in daily cleansing the parts and the passage of bougies until cicatrization is complete. However, in spite of every precaution, the posterior naris at the site of the operation frequently becomes again occluded by a thin cicatricial membrane. Should such a membrane form, it possesses but little vitality, and in 2 cases observed by the writer was destroyed by piercing it in two or three places with a small galvanocautery-knife, after which it did not recur.

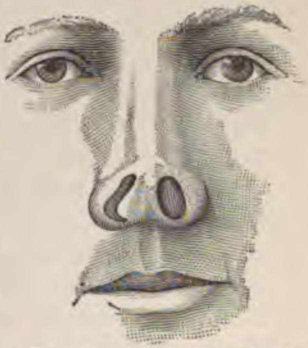


Fig. 59.—Dislocation of the columnar cartilage of the nose into the right nostril (Bosworth).

Dislocation of the Columnar Cartilage.—The so-called columnar cartilage is the inner plate of the lower lateral cartilage of the nose (Fig. 37), a small strip of cartilage lying parallel with the lower border of the septum, the purpose of which is to act as a support to the columna.

Dislocation of the columnar cartilage, as ordinarily seen, consists of the displacement laterally of the distal extremity of the septum in such a manner as nearly to occlude the affected nostril (Fig. 59).

Treatment.—The mucous membrane should be incised over the most prominent part of the deformity and the perichondrium elevated in such a manner as to allow the excision of a sufficient amount of the septal cartilage to restore the patency of the affected nostril. It is not generally necessary to suture the edges of the incision after the excision of the cartilage. No after-treatment is required.

Hematoma of the septum is an extravasation of blood beneath the mucous membrane of the septum, generally the result of traumatism. It presents itself as a blood-red tumor, sometimes large enough to obstruct nasal respiration.

Prognosis.—The blood may be absorbed, or infection may occur and an abscess result.

Treatment.—If the amount of blood is large, an incision should be made to allow it to escape. Should hematoma follow a submucous resection the wound should be reopened and the clot pressed out.

Abscess of the Septum.—*Etiology.*—Abscess of the septum may result from traumatism, syphilis, or phlegmonous inflammation of the septum.

Symptoms.—There may be the history of a chill, followed by fever, as in abscess elsewhere. Upon inspection the nose is found to be obstructed by a soft, fluctuating tumor of the septum. Generally the cartilage is soon perforated, so that the tumor becomes bilateral.

Treatment.—Early evacuation of the pus, to prevent extensive destruction of the parts involved in the inflammation and hasten resolution. The incision through the abscess should be sufficiently free to allow of syringing with normal salt solution if deemed necessary, and the patency of the opening should be maintained by the daily passage of a probe or the introduction of a drain of a few strands of chromatized gut or horse-hair. If a sequestrum of cartilage or bone form, it should not be removed until completely separated, and extreme care should be exercised to prevent injuring the mucous membrane of both sides of the septum, or a perforation of the septum will be present when the healing process is complete.

Septal perforations occur from traumatism or follow the removal of an exostosis or other septal operation. Extensive destruction of the septum sometimes results from tertiary syphilis, or a perforation may result at the anterior portion of the septal cartilage from simple ulceration.

Symptoms.—Posterior perforations present no symptoms, Anterior perforations of oblong shape sometimes cause whistling respiration, which disappears either wholly or in part if the perforation is made round. In this locality the edges of the perforation are not infrequently covered with crusts which cause slight hemorrhages when removed.

Treatment.—Posterior perforations are best left alone. Gottstein has pointed out that crusts only occur at portions of the perforation covered by cicatrice, and that if the mucous membrane is dissected back on both sides from the edge of the perforation and a portion of cartilage removed with a swivel knife, so that after healing the edge of the perforation is covered by normal mucous membrane, crusts cease to occur. For this reason crusts do not occur in perforations following submucous resections. In fact, even large perforations cause apparently no inconvenience and the patient's condition is infinitely better then if no operation had been done. Burton Haseltine has devised an operation in which a flap of mucous membrane is pulled forward over the aperture on one side and a similar flap pulled back on the other, thereby providing an intact membrane opposite each seam. The few stitches that are inserted must not produce tension.

Submucous infiltration of the septum is a comparatively frequent accompaniment of chronic rhinitis, consisting of an edematous tumefaction situated on each side of the septum, generally at its posterior portion.

Treatment.—If nasal respiration is obstructed, the masses may be scraped from the septum with the nasal curet or cauterized with the galvanocautery.

Injuries and Deformities of the Bony Framework of the Nose.—By far the most common result of nasal traumatism is dislocation of a portion of the septum from its attachment to the nasal processes of the superior maxillary bones. The dislocation is often overlooked at the time the injury is received because of the profuse hemorrhage. If a surgeon is consulted, his efforts usually are directed to controlling the flow of blood; and often he does not again see his patient for some days or weeks. Then the patient states that he can breathe only through one nostril.

Inspection of the nasal cavities shows a bulging area of septum in the obstructed nostril corresponding to a concavity upon the septum in the opposite nostril. If seen within a week or two of the injury, the parts should be cocainized. The surgeon then wets with sterile water the forefinger of his right hand if the patient's nostril is obstructed, or the left forefinger if the obstruction is in the patient's right nostril. With the palmar surface toward the septum and a slight boring motion the surgeon's finger is guided along the floor of the patient's nose. As the finger advances, pressure from the finger-tip readily forces the dislocated septum into a position median to both sides of the nose, after which the tube (Fig. 54) is inserted to act as a splint.

Flattening of the Bridge of the Nose or Saddle-back Nose.—A common result of nasal traumatism is fracture of the nasal bones at the root of the nose. The distal fragments are rotated outward on their long axes and depressed, producing a broadening and flattening of the bridge of the nose. When only one nasal bone is fractured, the tip of the nose is usually turned to one side as the result of dislocation of both lateral upper shield cartilages and the septum.

If the case is seen soon after the injury the displaced nasal bones are brought into position one after the other by means of Adams' forceps (Fig. 60), one blade of which is inserted into the nostril, so that the nasal bone can be grasped between the blades and lifted and turned into the normal position. When both nasal bones are in place they are supported by a roll of finger bandage on each side of the nose, held in place by a figure-of-8 bandage around the head; by a splint fashioned from gauze and collodion placed on the outside of the nose, or the nasal splint devised by Dr. W. W. Carter may be used (Fig. 61). The instrument is held in place by two sutures passed from within out through the bridge of the nose. Then the end of the nose is bent to one side by a loop of silver wire passed subcutaneously around one of the nasal bones, then through the nose and beneath the tissues into the mouth, where the ends are twisted about a molar tooth. Such a suture causes but little inconvenience and is in some cases superior to an external splint.

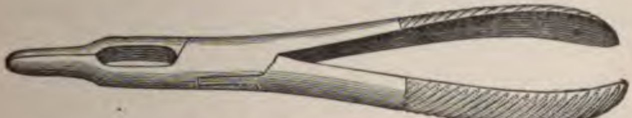


Fig. 60.—Adams' septum forceps.

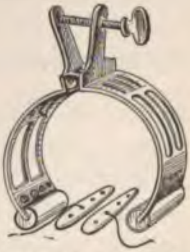


Fig. 61.—Carter's bridge and intransal splint.

Paraffin Prosthesis.—When the bones of the bridge of the nose are destroyed or greatly distorted as the result of syphilis or other causes, satisfactory results follow the injection of paraffin beneath the skin into the cellular tissue of the nose. A special paraffin is prepared by mixing ordinary paraffin with white vaselin until the mixture melts at about 110° F. (Formula 85). This special paraffin is readily injected at ordinary temperatures through a needle but little larger than an ordinary hypodermic needle by means of the screw-syringe (Fig. 62). As the screw is turned the paraffin exudes from the end of the needle in a worm-like thread, readily compressible between the thumb and finger. The paraffin, having been melted, is drawn into the barrel of the syringe, which it completely fills. The end of the syringe where the needle is screwed on is then closed with a screw-cap to prevent the escape of the paraffin. Then the syringe containing the paraffin and the needle to be used are dropped into the sterilizer and most carefully sterilized in boiling water. The syringe is then allowed to cool and the needle screwed into place ready to use.

The patient requires no special preparation other than washing the skin of the nose with green soap, alcohol, and, finally, corrosive sublimate solution (1 : 1000).

The end of the needle is inserted near the tip of the nose and thrust through the subcutaneous cellular tissue slightly beyond the deformity. Before beginning the injection the operator should assure himself that the point of the syringe-needle lies in the cellular tissue and hence is freely movable.

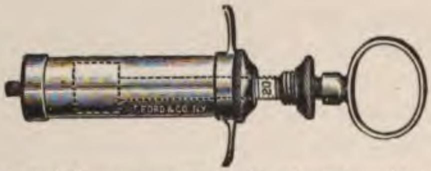


Fig. 62.—Harmon Smith's screw-syringe for the subcutaneous injection of paraffin.

The screw of the instrument is slowly turned and as the paraffin is pushed out through the needle it presses aside the cellular tissue and infiltrates it. The paraffin is molded into shape by the thumb and finger of the operator to the exact shape desired. The syringe-needle is then withdrawn a short distance, and more paraffin thrown into the cellular tissue, which is molded into shape; and so on, until the needle is finally withdrawn from beneath the skin of the nose. Before this is done care should be taken to break the thread of paraffin at the needle's point, so that paraffin will not be drawn *into the skin* as the point of the needle is withdrawn through it. The thread of paraffin is readily broken by grasping the point of the needle through the skin and rotating the instrument immediately before the needle is withdrawn.

Not more than 20 minims of paraffin should be injected at one sitting, in order to avoid injurious pressure and the cutting off of the circulation sufficiently to cause sloughing. It should be borne in mind that the operation is so simple and painless that it can be repeated as often as necessary to accomplish the desired result, so that it is foolish to attempt too much at one sitting.

Little or no swelling follows the injection, and the after-treatment consists in confining the patient to bed for twenty-four hours as a precaution and keeping him under observation for some days. Iced cloths or a 25 per cent. solution of aluminum acetate on cloths may be applied if edema or inflammation seem to require it.

Paraffin injections not only push the cellular tissue aside, but infiltrate it to a greater or less extent, so that if too much paraffin is injected it is impossible to remove it without removing the cellular tissue in which it is embedded. After all inflammation has subsided the paraffin feels somewhat like a little mass of fat beneath the skin, and is readily movable upon the bone beneath.

Unfavorable results from subcutaneous injections of paraffin have been reported as follows:

Infection followed by slough or abscess. Infection can be avoided by careful sterilization and by care to avoid leaving a cylinder of paraffin extending through the skin to the mass beneath.

Pressure necrosis, produced by injecting too much paraffin at one sitting or beneath the skin, where it is tightly bound down by adhesions.

Deformity from hyperinjection or depositing the paraffin in the wrong place. Ordinary skill, prudence, and the proper technic will prevent such a disaster from occurring.

Several cases of embolism have been reported from the injection of paraffin. When the paraffin is injected as a solid the danger is less imminent. It will, however, be well to have an assistant compress the sides of the root of the nose between his thumb and forefinger while the injection is being made. Paraffin remains only for some years beneath the skin, as it is finally completely absorbed, leaving behind it cellular tissue of the same shape and size as the paraffin.

In inoperable cases a false nose may be constructed of papier-mache suitably painted and attached to spectacle bows to hold it in place. A very life-like effect results from constructing the artificial nose of tinted gelatin which is molded while hot over a plaster cast of a normal nose. It is then fitted over the patient's deformed nose and held in place by varnish or mucilage. The edge of the prosthesis is made very thin and patted with hot cloths until it adheres closely to the skin. Being comparatively plastic the gelatin nose moves with the muscles of the face, giving a lifelike look to the new nose. It is stated that some patients learn to make gelatin noses for themselves, as they are required from time to time.

Congenital Deformities of the Nose.—The most common of the congenital deformities of the nose are a bulbous condition of the end of the nose and extreme prominence of the bridge. The latter is removed in the following manner: An incision is made through the skin and periosteum down to the bone. The periosteum is then stripped from the bone and the parts exposed. It is now a comparatively simple matter to remove the redundant bone and cartilage by means of a chisel. The skin and periosteum are then placed in their former position and the wound brought together by buried sutures, which leave no stitch-marks and a linear scar, which, in a year or two, becomes practically invisible.

When bulbous enlargement of the tip of the nose is excessive the redundant skin and fat is best treated by the method of Rodman, of Philadelphia, which consists of the removal of a pear-shaped piece of skin and subcutaneous structures, being careful not to disturb the cartilaginous framework of the nose. In cases where the deformity is less pronounced the operation devised by Roe, of Rochester, serves every purpose.

The end of the nose is turned upward and backward and held with a retractor by an assistant; then sufficient of the superfluous tissue is removed or dissected out from the inside of the nose to allow the nose to conform to the desired shape. However, great care must be exercised not to cut through into the skin, or a scar or dent in the external surface of the nose will result.

DISEASES OF THE ACCESSORY SINUSES OF THE NOSE

The cavities found in the bones of the skull communicating with the nasal chambers are the frontal sinuses, the antra of Highmore or the maxillary sinuses; the anterior and posterior ethmoid cells; the sphenoid sinuses and the lacrimal canals. The relative position of these sinuses in the face is shown in Fig. 63.

All of these except the sphenoidal and frontal sinuses exist at birth. The frontal begins as a slight depression extending up from the nasal fossa in the third fetal month. The ethmoid cells appear in early fetal life as depressions which enlarge by the absorption of bone. The sphenoidal sinuses are primarily a constriction of the primitive nasal fossa which occurs in the third fetal month; but neither the frontal nor the sphenoidal are well-marked cavites before the age of seven nor fully developed before the twentieth year. Experiments upon puppies and other young animals indicate that full development of the accessory sinuses is dependent upon unobstructed nasal respiration. In a young animal occlusion of both nostrils causes death. Occlusion of one nostril is followed by imperfect development of that side of the face including the accessory sinuses.

As the result of senile changes the accessory sinuses increase in size after the age of fifty and the frontals of the aged sometimes are enormous.

Because of the conical shape of the orbits, the lateral masses of the ethmoids are narrower in front than behind and consist of cells between nearly vertical walls: the os planum of the orbit and the ethmoidal portion of the lateral nasal wall. Above, the ethmoidal cells are capped by the frontal bone into which they partly extend; which is comparatively thick and contrasts strongly with the thin, fragile cribriform plate uniting the lateral masses of the ethmoid capsule, the os planum, the lateral nasal wall, and the bony partitions between the cells and between them and the sphenoid antrum.

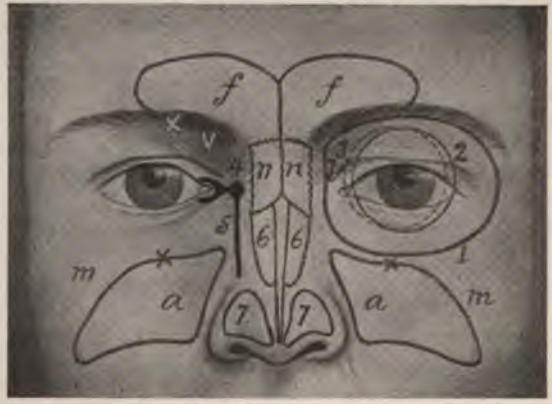


Fig. 63.—Relation of accessory sinuses, nasal bones and cartilages, canaliculi and nasal ducts, and sac to surface. Projection upon surface of outer margins of orbital cavity of conjunctival sac, and of globus oculi upon surface: *A*, Antra of Highmore; *F*, frontal sinuses (the white cross above the right upper lid shows the relation of the supra-orbital nerve to the frontal sinus; the black cross just beneath the lower lid indicates the relation of the infra-orbital nerve to the antrum); *N*, nasal bones; *1*, projection of margin of orbit upon surface; *2*, projection of eyeball (globus oculi) on surface; *3*, projection of conjunctival sac upon surface; *4*, lacrimal sac; *5*, nasal duct (from the lacrimal sac to the inner ends of both eyelids the lacrimal canals can be seen terminating at the eyelids in the puncta lacrimalia); *6*, lateral cartilage of nose (between the cartilage of each side is the cartilaginous portion of the septum, upon which they rest); *7*, alar cartilages. (Modified after Eisendrath.)

The capsules are divided into anterior and posterior ethmoidal cells by the lamina of the middle turbinate (Fig. 71). Anterior to this lamina are the laminæ of the bulla ethmoidalis and that of the unciform process; while posterior are the laminæ of the superior turbinate and of the partition between the ethmoid cells and the sphenoid antrum. The cells formed upon these laminæ vary in size and shape and occasionally protrude beyond the normal limits of the labyrinthine capsule. For example, an anterior ethmoidal cell may extend laterally over the orbit and anteriorly into the frontal bone. In cases where there is no frontal sinus, such an orbital cell may readily be mistaken for the sinus or lying in the frontal bone laterally to the sinus, for a double frontal sinus. One or more ethmoid cells sometimes occur between the orbit and the maxillary sinus and sometimes a cell develops above the sphenoid antrum. The appearance is that of an antrum divided into an upper and lower compartment by a *complete* partition. Such an ethmoid cell is always in intimate relation with the *optic nerve which in some cases actually passes through it.*

It is probable that suppuration occurs more frequently in cases of this abnormal development of the ethmoid cells; and because it is difficult or impossible to exenterate orbital or maxillary cells, a purulent discharge often continues after radical operations.

The key to the understanding of the relationship of the ethmoid cells and the accessory sinuses is the position of their ostea. Those of the anterior ethmoidal cells invariably open into the nose beneath the middle turbinate and those of the posterior cells above it, although because of the great variation in the shape and size of individual cells an anterior cell may extend back among the posterior cells or a posterior cell may extend forward among the anterior cells. In about 60 per cent. of cases the inferior bulla cell pierces the lamina of the middle turbinate to open above it and hence becomes a posterior ethmoid cell.

The septum between the frontal sinuses at its anterior point of origin upon the floor of the sinus is almost invariably in the central line; but the septum, instead of being in the median line and vertical, may extend laterally backward and upward in either direction and thus cause the sinuses to differ from each other greatly in size and shape; but both ostea are *invariably* present and in the usual position. Both sinuses may be absent, or only one exist, which may extend completely across the forehead. In such cases there is only one ostium and that in the usual position. *Incomplete* partitions may partly divide the frontal sinuses into several chambers, but a "double" frontal sinus in the strict sense of the word does not exist, as these partitions are *never complete* and there is *always* only one ostium to such sinuses.

The sphenoid antrum also is sometimes partly divided into several chambers by incomplete lamina; but it invariably has but one ostium which is always located in the upper half, generally in the upper third, of its anterior nasal wall posterior to a groove (spheno-ethmoidal sulcus), between the ethmoid and sphenoid and laterally to the posterior border of the superior turbinate.

The septum of the sphenoidal sinus like that of the frontal at its base anteriorly is almost invariably in the median line; but as it extends upward and backward may be so distorted as to render the sinuses not only different in shape and size, but one may actually extend beyond and back of the other. The posterior and inferior walls of the sinus are composed of thick bone. The anterior wall comprises an exposed or nasal portion in the upper half of which is the ostium and the thin partition between the posterior ethmoid cells and the antrum, which is a part of the ethmoid, so that when a skull is disarticulated this partition comes away with the ethmoid, leaving a wide opening into the sphenoid antrum. Upon the superior wall of the atrum lies the optic nerve. Because of a dehiscence in the bone the nerve sometimes lies directly on the antral mucous membrane. Upon the external wall is the cavernous sinus with the internal carotid running through it. Because of not infrequent dehiscence in this location the cavernous sinus may lie directly upon the mucous membrane, resembling in this respect the intimate relation sometimes existing in the middle ear between the mucous membrane and the bulb of the jugular vein; hence cureting the sphenoidal sinuses should be done only with the greatest caution if at all. As a matter of experience it has been found that if a sufficiently large opening be made in the anterior wall, the mucus soon becomes normal in suppurative cases, and therefore it is unnecessary to remove it. The same is true of other nasal accessory sinuses.

The ostium of the maxillary sinus lies at the bottom of the infundibulum beneath the bulla ethmoidalis. Unlike the other accessory nasal cavities there are not infrequently one or more other openings into the antrum through the so-called "membranous" portion of the median wall, Fig. 70.

The mucous membrane of all the sinuses is covered by ciliated epithelium so arranged that secretions, dust or bacteria are swept from the sinuses through the ostia into the nose, and hence the comparative rarity of sinus infection in spite of the fact that congestion and mild catarrhal inflammation of one or more of the sinuses is not uncommon in acute coryza; and is manifested by characteristic headaches, which quickly subside providing the virulence of the infection is not sufficient to destroy the epithelium and the ostia remain patulous. Chronic purulent inflammation is usually the result of prolonged occlusion of an ostium or some focus of infection discharging into a sinus, as, for example, a gangrenous tooth pulp into the maxillary antrum.

Much can be learned of the topography of the accessory sinuses by sectioning dried preparations, but better results are obtained by hardening the specimen in formalin solution and then clipping away the bone piecemeal from the mucous membrane, which has become hard and resilient and perfectly retains the original shape of the accessory cavities.

The accessory sinuses are phylogenetically ancient structures and, like the appendix, are residual organs, altho their presence in the skull adds lightness without greatly diminishing the strength of the bones of the face and nose. The antrum of Highmore has its prototype in the amphibian accessory nasal chamber, which is an organ of smell. It is suggested that the sinuses become active when the individual is forced to breathe dry air and help supply the deficiency of moisture. Because of their cellular structure the ethmoid capsules are good non-conductors and protect the orbital and intracranial structures from cold, a fact that should be borne in mind before deciding to exenterate these cells.

The accessory sinuses are all supplied by the trifacial nerve, and this fact should be borne in mind in tracing the route of reflex phenomena. While the postmortem examinations of general hospitals upon cadavers dead from all causes show the presence of mucopus in about 33 per cent.; yet microscopic examination of the lining mucous membrane of the sinuses show pathologic changes in only about 2 per cent., which corresponds more nearly with clinical observations upon the living.

Differential Diagnosis between Diseases of the Accessory Cavities.—In disease of the antrum, the frontal sinus, and the anterior ethmoid cells the discharge appears anteriorly beneath the middle turbinate. That from the posterior ethmoids and sphenoid antrum goes into the olfactory slit, or flows into the pharynx from the upper surface of the middle turbinate. If pus under the middle turbinate continuously reappears after being wiped away, it is not a local secretion, but is the overflow from one or all of the first series of cavities mentioned above. The presence or absence of pus in the antrum is readily ascertained by needle puncture (see Maxillary Sinus). If after thorough lavage of this cavity, pus reappears beneath the middle turbinate within an hour, or immediately after the use of a suction apparatus, its source is either the frontal sinus or the anterior ethmoid cells. If air is blown into the frontal sinus by means of a cannula (see Frontal Sinus) and pus is forced out, its source is, of course, the frontal sinus. The anterior ethmoid cells are almost invariably diseased in frontal sinus suppuration. However, secretions from them may flow downward into the antrum, but cannot flow upward into the frontal sinus.

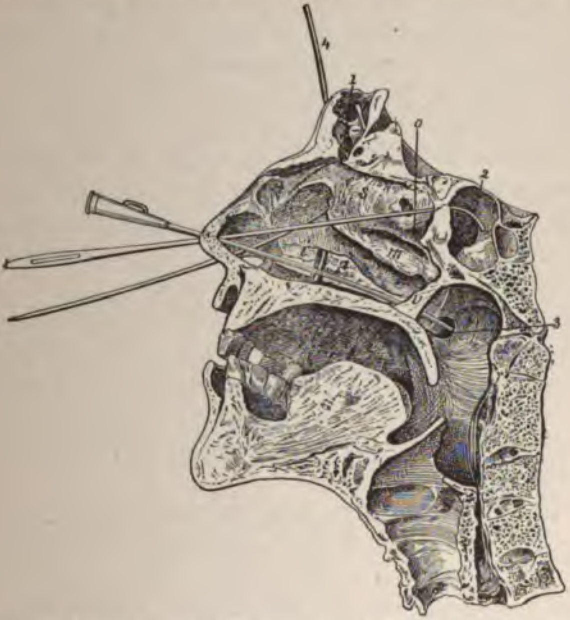


Fig. 64.—*1*, Frontal sinus, with probe entering it through the adnasal duct; *2*, sphenoid antrum, with probe entering it through its ostium; *3*, pharyngeal orifice of the eustachian tube, with catheter in position; *4*, Bowman's probe passed through the nasal duct into the nose, a portion of the inferior turbinated body has been cut away in order to show the point at which the probe enters the nose; *s*, *m*, *i*, superior, middle, and inferior turbinated bodies; *o*, ostium of the posterior ethmoid cells opening into the superior meatus; *v*, posterior portion of the Vomer; the rest of the septum has been cut away. (From a dried preparation.)

When the antrum is not infected, but simply is a reservoir for secretions of the frontal or anterior ethmoid cells, removal of the anterior end of the middle turbinate and if necessary the uncinate process prevents the entrance of pus through its ostium, and this absence of pus can be demonstrated by needle puncture.

[illegible] from the posterior ethmoids and sphenoid (second [illegible] that appears in the olfactory slit or upon the surface of the middle turbinate. Its source can usually be traced with the nasopharyngoscope (Fig. 19). After cocainization it is at times possible to expose the ostium of the sphenoid with a long Killian speculum (Fig. 14) and see a pulsating bead of pus exuding from its ostium. In other cases it will be necessary to remove the posterior part of the middle turbinate to bring the sphenoid ostium into view. If, after washing out this sinus, pus reappears upon its anterior surface within half an hour, the source of the pus is the posterior ethmoid cells. If under these circumstances no pus can now be washed out from the sinus, it is probably not suppurating and any pus removed by the former lavage was seepage from the posterior ethmoids.

Orbital abscess with consequent exophthalmos is most frequently the result of ethmoiditis, but may result from disease of the sphenoid or frontal. From ethmoiditis the direction of the exophthalmos is outward and forward: from the sphenoid directly forward and from the frontal downward and forward.

The pus is usually at first between the periosteum and the bone. The periosteum of the lamina papyracea may be dissected forward from the bone until it approaches the inner canthus or backward to the optic nerve. Ocular symptoms result either from the absorption of toxins, arterial or venous congestion, or actual thrombosis of intercommunicating veins between the sinuses and orbit. The larger quantity of blood from the nose is carried into the ophthalmic veins; but there are no communications between the lymphatics of the accessory cells and orbit. In mild cases there is simply congestion of the conjunctiva and possibly epiphora and edema of the lids. Paralysis of the internal rectus and superior oblique sometimes result from ethmoid disease and ptosis frontal sinus suppuration. Only in rare instances does bance of vision occur from disease of the frontal or maxillary sinuses, but the field of vision may be greatly restricted from sphenoid disease. There may be papillitis, neuroretinitis, choroiditis, or iridocyclitis. Blindness results sometimes from direct pressure of inflammatory products upon the trunk of the optic nerve.

Intracranial complications are phlebitis and thrombosis of the sinuses, meningitis, extradural, intradural, and cerebral abscess. Facial neuralgia is most commonly caused by disease of the maxillary antrum. Crust formations on the middle turbinate are most common in ethmoidal suppuration, but may be present when there is a scanty discharge from either the maxillary or frontal sinus.

Nasal polypi are most frequently the result, not the cause, of ethmoiditis, and polypi may be present not only in the ethmoid cells, but in any accessory cavity of the nose. Swelling of the nasal mucous membrane with pressure or irritation of its nerves from contact of two surfaces of swollen mucous membrane, as, for example, the middle turbinate and septum, may cause pain and headache without any accessory sinus disease. In fact, headaches in the orbital region with tenderness on pressure at the root of the nose is most frequently due to the middle turbinate being too large for the narrow space in which it lies, due to either hyperplasia or hypertrophy of the middle turbinate, or to deviation of the nasal septum. Pain in maxillary or frontal sinus disease is usually referred to the sinus involved; but in the case of the ethmoid or sphenoid, headache is vaguely deep seated or referred to the vertex or sides of the head. Supra-orbital pain may result from suppuration of either the maxillary or frontal sinuses. Sinus headaches are increased by bending forward. Pain is not usually proportionate to the amount of fluid in a sinus, but is often the result of "vacuum congestion," that is the negative pressure caused by the absorption of oxygen from the air contained in a sinus whose ostium is occluded. "Pressure pain" may usually be elicited in disease of the frontal sinus by pressing with the tip of the forefinger upon the anterior wall just above the supra-orbital ridge, or more frequently by pressing upon the floor of the sinus at the inner angle of the orbit. Pressure in this position toward the orbital plate of the ethmoid sometimes causes pain when the anterior ethmoid cells are inflamed. Pressure in the canine fossa over a diseased antrum usually causes pain, but in unilateral diseases of any nasal accessory cavity the degree of pressure tenderness should be compared with that of the opposite side.

Vertigo and momentarily blurred vision when stooping forward may be present in disease of any of the accessory sinuses.

The sense of smell may be perverted (*parosmia*), so that the individual imagines he smells a bad odor, or may be impaired or entirely lost (*anosmia*). The latter may be due to swelling of the ethmoidal mucous membrane or polypi preventing ventilation of the olfactory fissure.

Inflammation of the antrum of Highmore may be divided clinically into: Acute and chronic catarrhal inflammation and acute and chronic purulent inflammation.

Etiology.—The fangs of the first and second molar teeth usually extend into the floor of the antrum, the apex of the fangs not infrequently reaching a level above that of the rest of the floor of the antrum (Fig. 65). Under these circumstances it is easy to understand how caries of these molar teeth would infect the antrum, and undoubtedly gangrene of the molar pulp cavities is a frequent cause of chronic suppuration. However, closure of the ostium maxillare as the result of hypertrophic rhinitis and polypoid degeneration of the mucous membrane about this opening preponderates in the etiology of empyema. Some acute cases can be traced directly to the effects of influenza. The antrum may also be infected from disease of the ethmoid cells, the frontal sinuses, the sphenoidal sinuses, syphilitic necrosis, etc. In some instances the frontal sinus and the anterior ethmoid cells drain almost directly into the antrum, because the ostium maxillare is at the bottom of the infundibulum.

Pathology.—Soon after the onset of acute inflammation the mucous membrane of the antrum becomes greatly swollen and edematous and a large amount of seromucus is poured out. The inflammation may gradually subside at this stage provided the ostium is patulous or the secretion may become purulent. In old cases the cavity may be filled with foul, cheesy pus. The mucous membrane in some cases becomes enormously hypertrophied, pulpy, and covered with granulations and polypi, with areas of exposed bone.

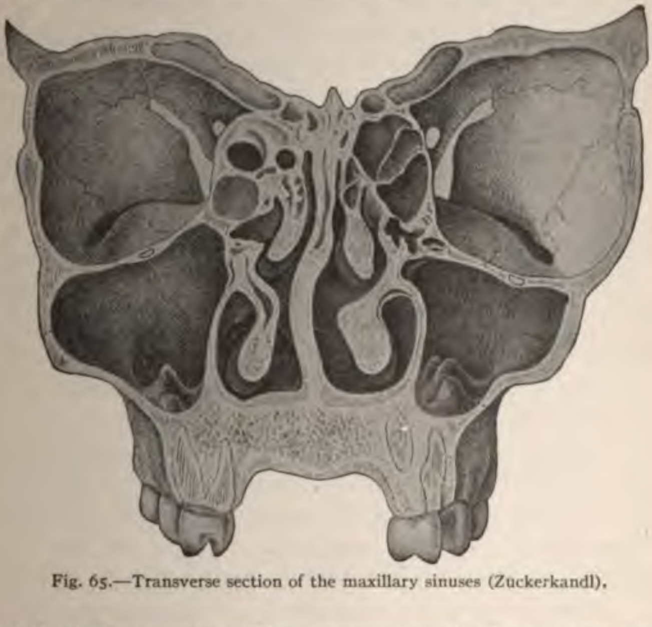


Fig. 65.—Transverse section of the maxillary sinuses (Zuckerkandl).

Symptoms.—At the beginning of the attack there is a sense of fulness and pressure beneath the orbit, and pain, sometimes agonizing in character, involving the whole side of the face.

In the more acute cases heat, swelling, and redness occur over the affected cavities in inflammation of either the antrum or frontal sinus.

Mastication is generally painful, the teeth of the affected side feeling as if elongated and crowded out of their sockets. These symptoms when due to a collection of fluid within the antrum and closure of the ostium maxillare may last for several days, when the fluid is either evacuated through the ostium maxillare or by an opening through the thin median wall; in rare cases the alveolus, the cheek, or the orbit. After this spontaneous evacuation the pus flows for a time, the course of the disease being marked by periods of retention, during which there is more or less pain, terminating by a discharge of somewhat fetid pus from the nostril. Some cases, however, pursue a chronic course from the commencement, there being at no time complete closure of the ostium maxillare and retention, nor any well-marked symptoms, except a unilateral catarrh, general ill health, with perhaps evening rise in temperature, which may, perhaps, occasion the erroneous diagnosis of "commencing tuberculosis," and the possibility of antral inflammation as a focus of infection in acute articular rheumatism and other diseases is worth consideration.

Diagnosis.—A discharge of pus from one nostril, especially if periodic in character, which smells and tastes fetid to the patient, should always excite the suspicion of disease of the antrum. Upon inspection the pus will be found flowing from beneath the middle turbinated body. This pus should be carefully wiped away with absorbent cotton and the patient be directed to lie down upon the unaffected side for ten or fifteen minutes, when, if pus reappears beneath the middle turbinated body it is probable that its source is the maxillary antrum. If, while the patient is in a dark room, a 3-candle-power electric lamp is placed within his mouth, the face will be lit up by transmitted light, and the outlines of each antrum can be mapped out if both are empty. If one is inflamed, that side of the face will appear darker. This is not due to the presence of pus, because the shadow will remain the same after this is removed, but to inflammation of the bone or thickening of the lining mucous membrane. The observer should also observe the manner in which the light is transmitted into each nasal chamber, and more especially through the eyeballs. In some cases both sides of the face will be equally illuminated by the transmitted light; but if the pupil of each eye be observed, that of the unaffected side will be the brighter, and also a half-moon-shaped portion of the lower eyelid immediately below the eyeball will be more brightly illuminated. *x*-Ray photographs often give valuable information as to the extent and size of the adnasal sinuses and presence or absence of disease; and in cases where it is suspected that disease not only of the antrum but also of other accessory cavities exists, this means of information should not be neglected; but pathologic conditions cannot be determined with certainty until the sinus has been opened, so that probably the simplest and most certain method of diagnosing the presence of pus is the introduction of a Lichtwitz needle into the antrum. After thorough cocainization beneath the turbinate and the tip of the septum, the point of the needle is introduced beneath the lower border of the inferior turbinate and passed upward and backward until the middle of the attachment of the turbinate to the nasal wall is reached (Fig. 67). In this position is the so-called "soft spot" where the wall of the antrum is usually so thin that no more force is required to penetrate it than to push a hypodermic needle through skin. However, should hard bone be encountered in this locality, a few blows with a small mallet on the shank of the needle will overcome the difficulty. Before making the puncture the proximal end of the septum on which the shank of the needle rests is strongly bent toward the opposite side of the face so that the point of the needle will penetrate the bone as nearly vertical to its surface as possible and the bevel of the needle point should be directed backward so that it will tend to penetrate the bone and not to slip along its surface beneath the mucous membrane. The thrusting of the small needle through the nasal wall should give no more pain than a hypodermic injection. Air forced through the needle with a large syringe will bubble through the contents of the antrum if it is filled with mucopus, producing a loud and characteristic bubbling noise. However, it should be borne in mind that in some acute cases the mucous lining of the antrum may be so swollen as to almost completely obliterate its cavity, so that the operator should be certain before blowing air with much force through the needle that its point has completely penetrated the lining mucous membrane. Because the floor of the antrum is rarely as high as that of the nose (Fig. 65) the needle will enter at a considerable distance above the floor of the antrum, and if the fluid within does not reach this level, there will be no characteristic bubbling sounds produced by blowing air through the needle. Under these circumstances the antrum should be cleansed by syringing normal salt solution into the antrum through the needle. If the patient's head is bent forward, the fluid will escape through the ostium and out of the nose and may be collected for examination in a bowl held by the patient. The salt solution is thrown into the antrum until no pus is washed out. The fluid remaining in the antrum is then removed by blowing air through the needle with the syringe.

If it is impossible to syringe through the needle without undue force, the needle may not have entered the antrum, Fig. 67; it may be stopped up by a little spicule of bone, the ostium may be occluded, or the lining mucous membrane may be so swollen as to nearly fill its cavity. When its ostium is occluded, the pus should be aspirated from its cavity. If the needle is stopped up, it should be withdrawn, cleansed, and reintroduced.

Prognosis.—Resolution generally occurs in acute catarrhal cases the result of transient closure of the ostium maxillare from simply taking cold. Chronic suppuration of the antrum rarely if ever gets well without operation.

Treatment.—Success in all acute cases of accessory sinus disease depends largely upon the restoration of ventilation and drainage. An effort should be made to restore the patency of the ostium maxillare in the following manner: The parts about the middle turbinated body should be thoroughly cocainized by means of pieces of absorbent cotton saturated with a 4 per cent. solution of cocain placed within the middle meatus, and a few drops of a 10 per cent. solution of argyrol injected beneath the middle turbinate by means of a hypodermic syringe with a long malleable silver nozle (Fig. 28). These applications should be made daily at the physician's office, the patient in the meanwhile using at home every hour or two a spray of adrenalin of the strength of 1 : 10,000.

This treatment is curative in some mild catarrhal cases. However, if much mucopus is washed from the antrum with a Lichtwitz needle when used for diagnosis, it will be necessary to repeat this irrigation daily; but if after twelve days pus is still washed from the antrum, the disease is probably an acute exacerbation of a chronic suppuration and more radical procedures will be required to bring about a cure.

The accessory sinuses can be inflated with a Politzer bag or by *Valsalva's method*, that is, closing the nose and blowing violently into it. They may be aspirated by inserting the nozle of a Politzer bag into the patient's nose and allowing the empty bag to expand while the patient is blowing out his cheeks. Closing the nostrils and sniffing violently has a tendency to aspirate the accessory sinuses. In some cases the rarefaction of the air by this method in an inflamed antrum is sufficient to cause pain, and in certain cases is sufficient to enable a patient to aspirate fluid from this antrum when in the horizontal position with the affected antrum uppermost.

Formerly chronic suppuration of the antrum was treated almost exclusively by the Cooper method (1717, previously described by Meibomius, who died in 1655). A molar tooth was drawn and the antrum entered through the inner root socket by means of a conical drill. Generally a carious tooth could be selected, but when a sound tooth was sacrificed, the second molar was chosen. Occasionally the opening was made through the canine fossa. Figure 66 shows a condition where it would be very difficult to enter the antrum through the alveolus. The antrum was washed out daily either by the surgeon or the patient. This method is still justifiable in necrosis when, after removal of one or

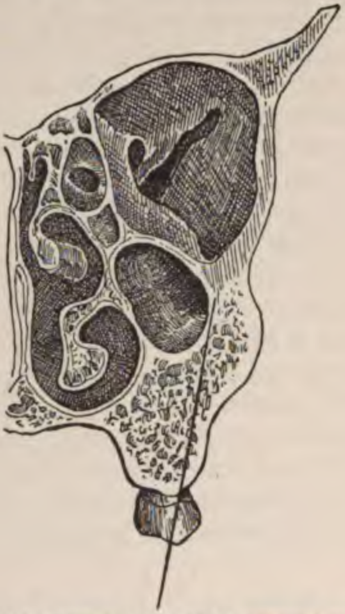


Fig. 66.—Illustrating the difficulty of opening the antrum through the root cavities when the antrum is small or abnormal in location.

more of the molars and surrounding necrosed bone, a large opening into the antrum results. It is astonishing in some such cases how quickly a cure of the suppuration results from a few daily irrigations. However, openings from the mouth into the antrum quickly close if a plug of vulcanite or metal is not constantly worn to keep them open; and daily irrigation for years is sometimes unsuccessful in bringing about a cure.

An opening through the nasal wall beneath the inferior turbinate closes more slowly because the bone is thin, and if large sometimes remains open sufficiently long to bring about a cure of a chronic suppuration; because even without irrigation the antrum is cleansed by its secretions constantly escaping into the nose.

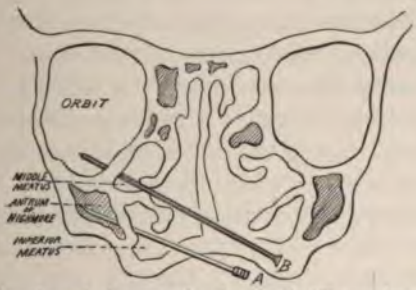


Fig. 67.—Section through the nose, showing needle (*B*) entering the orbital cavity through the middle meatus when the lateral wall slopes outward; *A* shows needle entering the antrum through the inferior meatus. Outline: Zuckerkandl, Anatomie der Nasenhöhle (Coffin).

Opening the antrum through the nose was apparently first proposed by Grouch, an English surgeon, who died in 1780. Such openings are readily made either with or without the previous removal of the anterior third of the inferior turbinate with Wagner's punch, Weil's saw, Welaminsky's perforator, Well's rasp cannula, Gleason's perforator and rasp, and by other methods. Should such an opening close prematurely, it is readily reproduced, because it is closed not by the bone, but by thin cicatricial tissue which is easily penetrated and removed. The parts are cocainized as for an ordinary needle puncture. The triangular sharp end of Gleason's perforator is then placed upon the "soft spot" and a few half-turns causes it to cut its way into the antrum. As it is withdrawn the bone is rasped away sufficiently to permit the introduction of the blunt end of the instrument and a sufficiently large opening quickly rasped from the antral wall into the nose. The operation is comparatively painless if the parts have been sufficiently cocainized. The antrum is irrigated each day either by the surgeon or the patient with a eustachian catheter as long as there is any discharge, when the opening is allowed to close. Should exuberant granulations from the edge of the wound obstruct drainage from the antrum, they should be scraped away by introducing the blunt-end of the instrument through the wound. Sullivan prefers to open the antrum after infracting the inferior turbinate by means of a long Killian speculum or Luc ethmoid forceps. The inferior turbinate is now pushed upward by the speculum in such a manner that a clear view of the nasal antral wall beneath it is obtained, and an opening about 1 inch long extending from the insertion of the turbinate nearly to the floor of the nose is made with the rasp (Fig. 68) or a mastoid curet, and shreds of bone and mucous membrane removed by suitable punch forceps. Such an opening is a long time in closing.

For cleansing the antrum sterile normal salt solution is probably the most convenient, but a saturated solution of boric acid may be employed. To either of these solutions a small proportion of hydrogen dioxid may be added. Foul odor is best overcome by syringing with 1 : 1000 permanganate of potash or 1 per cent. silver nitrate may be thrown into the antrum and after a few moments removed by syringing with normal salt solution. However, in most chronic cases alcohol gives the best results. After cleansing with normal salt solution the antrum is filled with 50 per cent. alcohol, which is allowed to remain. Should this cause only momentary discomfort the strength of alcohol is increased at subsequent sittings until 95 per cent. is used. When the secretions instead of being purulent and rendering the irrigation fluid flocculent become mucoid so as to form a jelly-like mass floating in clear irrigation fluid, the case is rapidly advancing toward a cure. The permanency of the cure will depend largely upon the patency of the ostium maxillare and the condition of the structures about this opening should receive careful attention.

Radical Operations.—In some cases intranasal treatment is insufficient to bring about a cure of chronic suppuration. Radical or, as sometimes called, "external" operations have been devised by Küster, Janson, Caldwell-Luc, Denker, and others.

Janson claims that when one sinus is involved, all the sinuses of that side of the head are probably more or less affected. In America the operation is employed mostly for the removal of malignant growths involving the antrum and nose. A postnasal tampon is first placed in the nasopharynx. An incision is made alongside the nose, then below the nose to the columna, and then through the lip into the mouth. The flap is dissected back to expose the anterior bony wall of the antrum. This, together with the nasal process of the superior maxillary, is removed as in the Denker operation. The growth is then rapidly excised, the ethmoidal labyrinth is torn away with alligator forceps, the thin wall between the posterior cells and the sphenoid antrum is broken down, and its cavity widely opened. In a number of cases of malignant growths operated by this

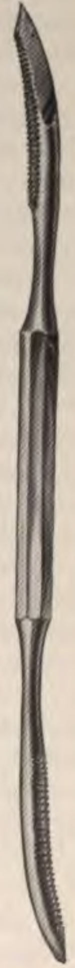


Fig. 68.—Gleason's antrum rasp.

method the hemorrhage was easily controlled by packing with iodoform gauze and there was ample opportunity to carefully inspect the parts and remove all tissue that seemed infected.

Caldwell-Luc Operation.—The patient is etherized and the foot of the operating table slightly elevated. To prevent blood reaching the pharynx a strip of gauze is packed between the jaw and the cheek beyond the wound and removed from time to time as it becomes saturated with clots. In spite of this very important precaution a certain amount of blood usually reaches the pharynx, especially during the later part of the operation, and a mouth-gag, tongue-depressor, and long Kocher's hemostats for sponge-holders should be at hand for its removal.

The cheek and upper lip are elevated by means of blunt retractors and an incision made at the junction of the cheek and jaw from the posterior border of the alveolus to just below the nasal septum through the mucous membrane and periosteum. The anterior and lateral walls of the antrum are now uncovered by means of a periosteum elevator and the bone removed with chisel and rongeur forceps as far forward as the nasal wall, and backward to the anterior border of the masseter muscle, and vertically from the floor of the antrum to near the infra-orbital canal. If the lining membrane is not wounded, the operation up to this point will be nearly bloodless.

The mucous membrane is incised and the cavity of the antrum examined with the finger, and after hemorrhage has ceased, inspected. The hemorrhage which follows incision of the red and swollen mucous membrane will be profuse. It is controlled by packing the antrum with iodoform gauze, at least the mucous membrane of the floor of the antrum may be diseased beyond repair and require removing. This now is done by separating the mucous membrane from the bone by inserting a curet between them. When greatly inflamed and swollen it peels off readily and is often easily removed in one piece. The antrum is freed from blood, bony septa broken down and removed with the curet, and a larger opening made in the nasal wall. This is best started by making two rectangular cuts through the thin bone of the nasal wall with Killian's angular chisels (Fig. 69), care being taken not to penetrate the nasal mucous membrane if it can be avoided. The square plate of bone inclosed by the chisel cuts is carefully lifted off the nasal mucous membrane and the rest of the nasal bony wall cut away with curet and rongeur forceps. If possible the nasal mucous membrane is preserved and at the conclusion of the operation turned into the antrum to cover its floor. It adheres to the floor and shortens somewhat the time required for healing. The preservation of the nasal mucous membrane will be facilitated by placing the little finger within the nose from time to time while the bony nasal wall is being removed. However, if most of it is sacrificed during the operation, it need cause no anxiety, as it does no harm except to lengthen the time required for healing.

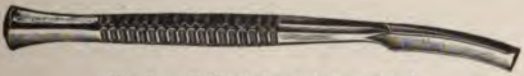


Fig. 69.—Killian's frontal sinus chisel.

The lacrimal duct enters the nose beneath the inferior turbinate at the angle formed by its oblique and horizontal attachment to the antral wall. It is about on a level with and not far from the infra-orbital foramen, and is situated so high up that the greater portion of the nasal wall can be removed without injuring it. However, whether the duct is injured or not the patient generally has epiphora, which after a time subsides. It is better to remove at least the anterior third of the inferior turbinate. The lower portion of the nasal wall should be removed so completely that there shall be no ridge of bone between the nasal floor and that of the antrum. The operation is completed by inspecting all angles withi the antrum for necrotic areas or diseased mucous membrane, which if found are removed. The remains of the nasal mucous membrane of the nasal wall of the antrum is now turned into the antrum to replace as far as possible its own mucous membrane, and if necessary held in place with a stitch. The end of a strip of gauze is passed through the antrum into the anterior nares and the rest of the strip packed loosely into the antrum. The oral wound should not be stitched, as it heals readily. The iodoform gauze is partly removed on the second day through the nose and the rest of the strip on the third day. The after-treatment consists in syringing normal salt solution through the nose as long as there is secretion. During the healing the antrum becomes greatly reduced in size.

Denker's operation differs from the Caldwell-Luc to the extent that the anterior inferior angle of the antrum is obliterated by removing with chisel and rongeur the nasal process of the superior maxilla from the floor of the nose to the level of the infra-orbital foramen.

Diseases of the frontal sinus are acute catarrh or suppuration, chronic catarrh or suppuration, confined suppurations, mucocele, tumors, foreign bodies and local manifestations of syphilis, tuberculosis, or some other systemic infection. Acute catarrh of the frontal sinus probably is more common than similar disease of any of the other accessory sinuses. The disease, however, more rarely goes on to suppuration because the ostium often affords ample drainage from the most dependent portion of the cavity.

The *symptoms* of acute sinus inflammation are frontal headache, sometimes severe pain, with nausea and vomiting. Redness and swelling over the sinus and edema of the eyelids. Severe infection extends to the meninges with characteristic symptoms, according to some authors more frequently in accessory sinus disease than in otitis. When a transilluminator is placed beneath the brow, the light is transmitted better by a large normal sinus than by one containing pus or a tumor. However, the size and shape of the frontal sinus varies so greatly in different individuals that a more satisfactory result can be obtained by an *x*-ray photograph than by transillumination. It is usually possible, by means of a good photograph, to not only determine whether the sinus contains pus or a tumor, but also secure valuable information as to its size, the presence or absence of septa, the condition and size of the ethmoid cells, the antra of Highmore, etc.

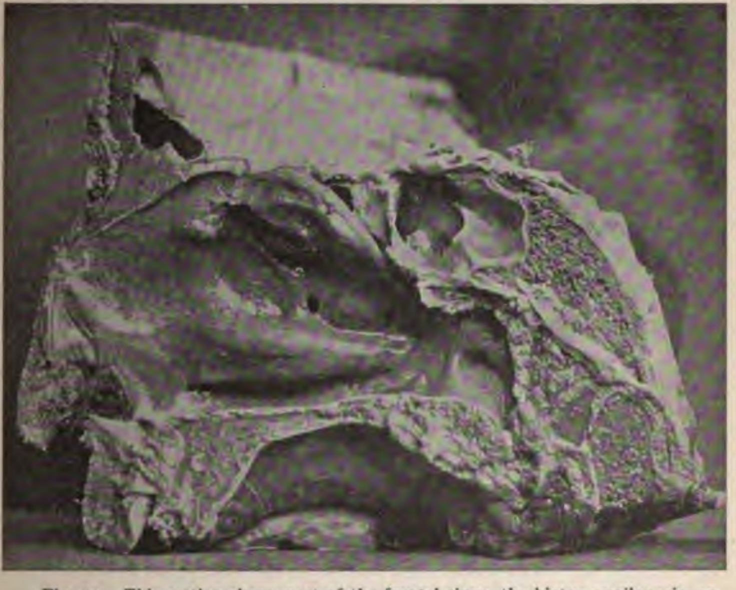


Fig. 70.—This section shows part of the frontal sinus, the hiatus semilunaris, an accessory opening into the antrum, the inferior turbinated body, the eustachian tube opening behind this and the sphenoidal sinus, with a partial septum near its center. In front of this sphenoid are the posterior ethmoid cells (not opened), and between these two is the spheno-ethmoidal sulcus. The middle turbinated body has been lifted upward to show the structures beneath it. It remains attached by part of its upper edge to the ethmoid body (Douglass).

The *infundibulum* is a narrow groove in the outer wall of the nose. Its crescent-shaped opening into the middle meatus is the *hiatus semilunaris*. The *frontonasal canal* or duct, as the upper anterior portion of the infundibulum is called when it becomes a closed canal by becoming covered at its median side by the anterior attachment of the middle turbinate, generally extends upward from the infundibulum to the frontal sinus, where its opening is called the *ostium*

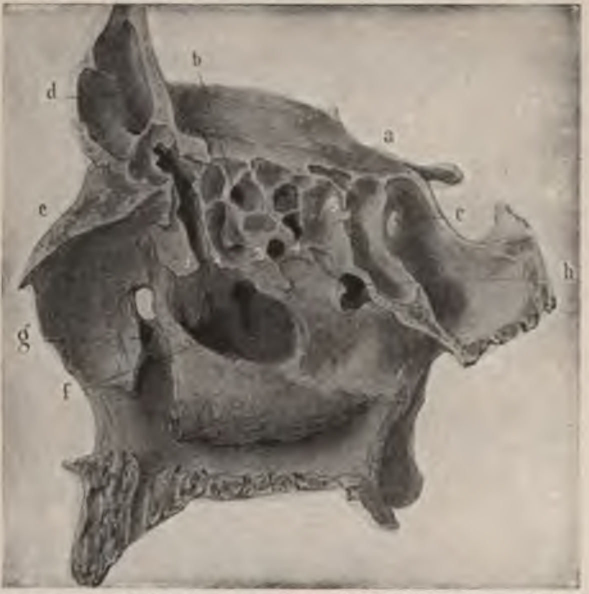


Fig. 71.—*1, 2, 3, 4, 5.* Laminæ or partitions of the uncinate process, bulla, middle, superior, and supreme turbinates. *a*, Posterior ethmoid cells, opening together with the sphenoid antrum *c* into the superior meatus; *b*, anterior ethmoid cells, opening together with the frontal sinus and maxillary antrum into the middle meatus; *e*, infundibulum leading upward to the ostium of the frontal sinus, *d*, when covered by the anterior attachment of the middle turbinate, the upper portion of the infundibulum is converted into the nasofrontal duct; *f*, hiatus maxillaris; *g*, anterior portion of inferior turbinate removed to show lacrimal duct which is laid open.

frontale. However, in 50 per cent. of cases the upper portion of the infundibulum is not inclosed, and hence there is no nasofrontal duct and the ostium opens directly into the middle meatus beneath the anterior extremity of the middle inate. The distance from the floor of the frontal s through the nasofrontal duct if it exists is rarely more [illegible] inch. The distance from the nasal end of the duct to the lower border of the bulla ethmoidalis, the lowest possible region of obstruction to frontal drainage, is about ¾ inch (Fig. 71).

Treatment.—The headache and pain can sometimes be relieved by cocainizing the parts and inflating the frontal sinus with menthol-iodin-chloroform vapor. Should this maneuver succeed, Politzer's bag should be used at sufficiently frequent intervals to prevent a return of the frontal headache. The patient should spray the middle turbinate region of his nose every two hours with a 1 : 10,000 solution of adrenalin as a home treatment, and every effort should be made to maintain the ostium in a patulous condition until the inflammation of the frontal sinus subsides.

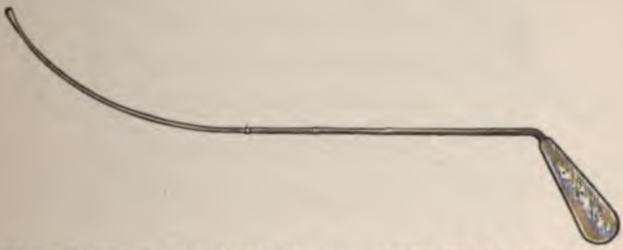
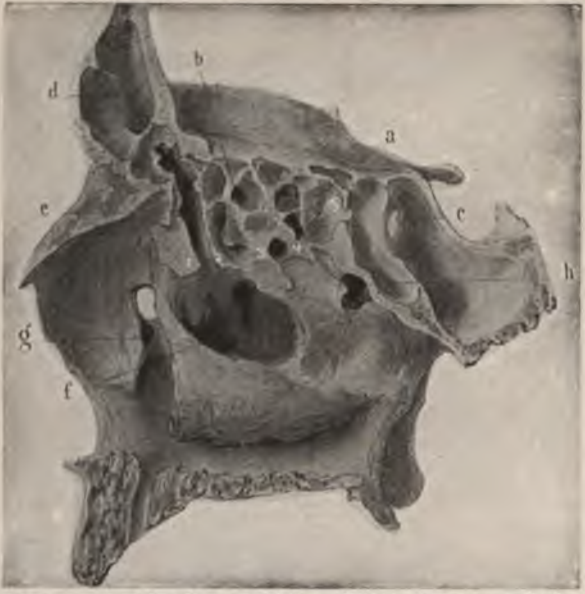


Fig. 72.—Vienna sinus probe. This probe or sound is perfectly flexible and may be bent in any desired shape for sounding the frontal, maxillary, or sphenoidal sinuses.

This treatment is only adequate in the milder catarrhal inflammations. When fluid has accumulated within the sinus it should be removed by a suction apparatus (p. 190).

Not infrequently a small polypus is found beneath the middle turbinate anteriorly, and its removal is followed by a cessation of recurrent attacks of frontal sinus inflammation. However, the obstruction generally is due to swelling or hyperemia of either the lateral wall of the middle turbinated body or the mucous membrane of the infundibulum, the uncinate process, and the bulla ethmoidalis. Suitably treated, at least 95 per cent. of acute cases recover without operation, but where relapses are frequent it is advisable duct, as the upper anterior portion of the infundibulum is called when it becomes a closed canal by becoming covered at its median side by the anterior attachment of the middle turbinate, generally extends upward from the infundibulum to the frontal sinus, where its opening is called the *ostium frontale.* However, in 50 per cent. of cases the upper portion of the infundibulum is not inclosed, and hence there is no nasofrontal duct and the ostium opens directly into the middle meatus beneath the anterior extremity of the middle turbinate. The distance from the floor of the frontal sinus through the nasofrontal duct if it exists is rarely more than ⅜ inch. The distance from the nasal end of the duct



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to the lower border of the bulla ethmoidalis, the lowest possible region of obstruction to frontal drainage, is about $\frac{3}{4}$ inch (Fig. 71).

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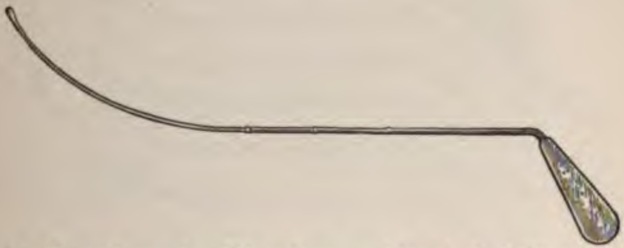

Fig. 72.—Vienna sinus probe. This probe or sound is perfectly flexible and may be bent in any desired shape for sounding the frontal, maxillary, or sphenoidal sinuses.

This treatment is only adequate in the milder catarrhal inflammations. When fluid has accumulated within the sinus it should be removed by a suction apparatus (p. 190).

Not infrequently a small polypus is found beneath the middle turbinate anteriorly, and its removal is followed by a cessation of recurrent attacks of frontal sinus inflammation. However, the obstruction generally is due to swelling or hyperemia of either the lateral wall of the middle turbinated body or the mucous membrane of the infundibulum, the uncinate process, and the bulla ethmoidalis. Suitably treated, at least 95 per cent. of acute cases recover without operation, but where relapses are frequent it is advisable to remove the anterior ethmoid cells. In a large proportion of cases the removal of the cells exposes the ostium and permits the introduction of a small curet or rasp (Fig. 73) by which the ostium if necessary may be still further enlarged at the expense of its anterior and lateral border.

Chronic Purulent Disease of the Frontal Sinus.—Symptoms.—The headache is usually persistent, but may assume an intermittent type. There may be deep-seated pain on pressure on the floor of the sinus at the inner canthus. Upon inspection the parts about the infundibulum are red, swollen, and covered by a small amount of pus, sometimes offensive in character. If the discharge is greatly obstructed, the roof of the orbit may be so far crowded downward as to produce displacement of the eyeball with diplopia or even amaurosis. Should the posterior wall be necrosed, dulness, apathy, increased headache, and other symptoms referable to the brain will probably manifest themselves. Meningitis or brain abscess may occur.

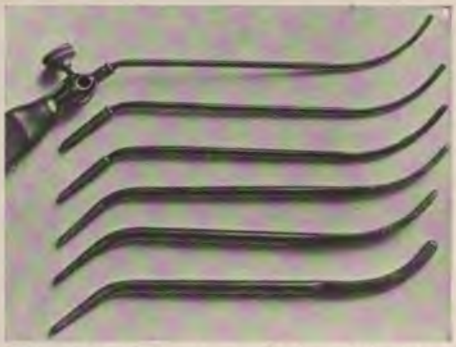

Fig. 73.—Sullivan's frontal sinus rasps. Six sizes—fitting into one handle.

Treatment.—Chronic cases require treatment by aspiration (p. 190) and possibly irrigation with a mild alkaline solution. This may be accomplished by means of Hartmann's cannula (Fig. 74). This cannula should be made of virgin silver, so that its curve can be slightly changed to suit varying conditions. The parts are first cocainized and an effort made to probe the sinus with a small virgin silver probe (Fig. 70). About 1 inch from its tip the probe is curved somewhat abruptly at an angle of about 70 or 80 degrees. The region of the bulla ethmoidalis is located and the tip of the probe inserted beneath the middle turbinate immediately in front of the bulla so that the tip will rest upon the upper edge of the uncinate process. With this as a guide the tip of the probe is moved forward and upward until it is felt to enter a cavity which may be either the sinus or an anterior ethmoid cell. If the tip of the probe is in the sinus it will enter within the nose from 7 to 11 cm. according to the size of the sinus. The tip of the probe will be also somewhat freely movable within the sinus. If the operator is in doubt, he may withdraw the probe and place it alongside the patient's nose with its tip on the forehead in such a manner as to compare its curve with the contour of the patient's face, and if necessary slightly change the curve of the probe before attempting to probe the sinus again. In many cases the nasofrontal duct is not a direct continuation of the infundibulum which ends either as a blind pouch or in an anterior ethmoid cell. The ostium frontale with or without a short duct opens under the anterior end of the middle turbinate in a line with the unciform groove and a little above it. Hence when the probe enters the blind pouch in which the infundibulum sometimes ends or enters an anterior ethmoid cell, it should be withdrawn and an effort made to locate the ostium frontale further back. Generally the probing is

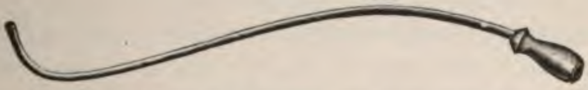

Fig. 74.—Hartmann's frontal sinus cannula. The instrument should be made of pure, soft silver, so that its curve can readily be slightly changed. However, all of the accessory sinuses can be reached by a pure silver eustachian catheter, which can, of course, be attached to a syringe.

facilitated by bending the very tip of the probe laterally at an angle of 5 or 6 degrees. As force is absolutely unnecessary, great gentleness should be used in probing the sinus; for the cribriform plate is not far distant from the field of operation. When the probe has entered the sinus, it is withdrawn; the shape of the cannula is bent to correspond with that of the probe, and inserted into the sinus. The solution used for syringing should be of a temperature of about 120° F., and great gentleness should be employed in syringing to avoid giving pain.

If necessary to improve drainage and facilitate cleansing and medication of the sinus the ostium may be enlarged with Suliran's rasps (Fig. 77). The use of these instruments usually destroy the nasofrontal duct and one or more of the anterior ethmoid cells. Should there be difficulty in probing the frontal sinus and the circumstances require it, the anterior ethmoid cells should be removed with a curet, after which the sinus is usually readily probed and its ostium enlarged with Suliran's rasps. As in the external operation for exenteration of the ethmoid labyrinth (page 184) the lacrimal bone is the guide to the position of the anterior cells. This is readily located by pressing the forefinger tip into the tissues at the inner canthus, a medium-sized mastoid curet (Fig. 190) is passed above the anterior attachment of the middle turbinate and its concave surface pressed firmly into the cells which are opened by rotating the curet backward and downward. The septa between the cells are then removed with alligator forceps. With the forefinger of the disengaged hand pressing on the lacrimal bone there is little danger of injuring either this structure or the os planum, but should the orbit be penetrated no harm results besides swelling and discoloration of the eyelids, which subsides within a few days (Mosher).

After the sinus has been thoroughly cleansed, any retained fluid should be removed by blowing air through the cannula with the syringe. After the sinus has been cleansed and dried, ½ dram of a 10 per cent. solution of argyrol or alcohol, 50 to 95 per cent., should be injected through the cannula by means of syringe *a*, Fig. 28, and allowed to remain.

In many cases the discharge loses its fetid odor and becomes mucoid, but never entirely ceases. However, there is no headache except during acute exacerbations of the disease. Some of these cases are improved for the time being at least by the use of autogenous vaccines or by injecting into the sinus pure cultures of the Bulgarian lactic acid bacillus; but these measures are sometimes inadequate to bring about a cure and an external operation for obliteration of the sinus is necessary.

Killian states that the following conditions indicate an external operation:

"1. When other operations have failed.

"2. When there are indications of necrosis, as a fistula or abscess.

"3. When there are symptoms of intracranial complications.

"4. When in a case of chronic purulent frontal sinusitis pain and fever appear with a foul-smelling discharge.

"5. When there is headache, particularly when associated with discomfort in the region of the eye, which is not relieved by intranasal treatment.

"6. When, in spite of oft-repeated irrigations of the sinus, the discharge remains foul.

"7. When the inflammation of the frontal sinus and anterior ethmoid cells produces recurring groups of polypi.

"8. When a simple purulent discharge is not relieved by careful intranasal treatment, and the patient desires permanent relief by a radical procedure."

Bryan, Hajek, Killian, Agston, Luc, and Kuhnt have devised operations for exposing the frontal sinus by removing a portion of its external wall. Küster, Lathrop, Beck, and others have devised osteoplastic operations in which a flap of periosteum and bone is replaced after the sinus has been cureted.

Killian's Operation.—The field of operation is sterilized in the usual manner; the nostril is filled with a strip of selvedged iodoform gauze which is removed and replaced from time to time as required during the operation. A mouth-gag, tongue-depressor, and sponge-holders should be at hand to remove blood that finds its way into the pharynx. A semicircular incision is made along the eyebrow from near its temporal end to the side of the nose and thence downward along the side of the nose to below the inferior border of the orbit, whence, if necessary, it extends for a short distance outward. A somewhat sharp hemorrhage from arteries near the root of the nose will necessitate the application of several hemostats. The periosteum is incised just beneath the inferior border of the temporal ridge and along the side of the nose, and the periosteum and tissues of the orbit separated from the bone and held out of the way with an "eye protector." For this purpose an ordinary tongue-depressor may be employed, but care should be exercised during the entire operation that injurious pressure is not made upon the eyeball either by the "protector" or hemostats beneath it.

A second incision through the periosteum is now made about $\frac{3}{8}$ inch above the superciliary ridge and parallel to its inferior border, and the bone of the forehead above this line denuded of its periosteum to the upper limits of the frontal sinus as determined by a skiagraph before the operation. Should the frontal sinus be large and extend high up upon the forehead, it will be necessary to make a second incision through the skin and periosteum vertically from the first at the root of the nose, thus producing a triangular flap of skin and periosteum which is lifted up from the bone. The periosteum and bone of the superciliary ridge are left intact as a bridge, that as little deformity as possible shall result from the operation. The width of the bridge should be about that of the base of the nasal bone of the side operated upon. As a continuation of the base of the nasal bone at the completion of the operation it arches upward and outward to the lateral limit of the sinus. Extreme care is necessary at certain stages of the operation to avoid fracturing it.

The periosteum is incised somewhat above the line of this bridge so that it can be turned over the superior surface of this bridge and form a covering for the upper surface of the bridge. The boundary of the upper border of the bridge is marked out by a groove made with Killian's triangular chisel (Fig. 69). This groove is deepened by successive chiselings until the mucous membrane of the antrum is reached. The mucous membrane is pushed out of the way with a probe, and enough of the bone removed with a gouge to permit the probe being inserted in every direction between the mucous membrane and the bone and the boundaries of the antrum shown by the skiagraph verified. With chisel and rongeur forceps the entire outer wall of the frontal is removed. The swollen mucous membrane is now lifted up from the bone with a separator, and removed entire with a pair of forceps. As the mucous membrane when thickened and inflamed is attached very loosely to the bone its removal is usually a matter of little difficulty, a small gouge answering well as a separator. All overhanging ridges of bone are chiseled away, all angles of softened bone are smoothed down with a curet, so that no dead spaces remain when the wound is completed. The operator now proceeds to remove the floor of the antrum, and thus form a large opening into the nose.

The periosteum of the orbit above and at the side of the nose is carefully separated from the bone until the lacrimal sac is reached, which is lifted from its groove, exposing the lacrimal bone, which is punctured with a chisel and removed with alligator forceps (Figs. 46 and 75), exposing the anterior ethmoidal cells.

The articulation of the nasal process, of the superior maxillary, the nasal bone, and the frontal form a **T**-shaped suture which is readily perceived when the bones are bared of their periosteum. The floor of the frontal sinus lies immediately above where the vertical portion joins the horizontal portion of the **T**-shaped suture, and the floor of the sinus should be removed with a gouge, and also a sufficient portion of the nasal process of the maxilla to secure sufficient room for the use of alligator forceps (Figs. 46 and 75). At least the anterior ethmoidal cells are torn away with this instrument, including the outer wall of the orbit (lamina papyracea). When the entire ethmoid is suppurating the cells are bitten away with the forceps until the outer wall of the sphenoid is reached; which is also removed. The bony floor of the antrum, which is also the roof of the orbit, is entirely removed with the forceps and all angles smoothed down with a curet.

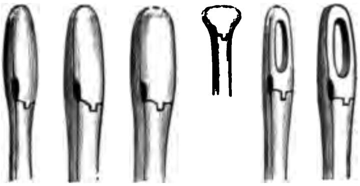

Fig. 75.—Alligator forceps.

A strip of selvedge-edged iodoform gauze is inserted from the antrum into the nose. Above this another strip of gauze is inserted at the inner angle of the wound and another protruded from the outer angle. The skin wound is then brought together with sutures so arranged that the pulley of the superior oblique is brought as nearly as possible back into its original position. Because of the large opening into the nose the skin over the wound moves inward and outward with each breath of the patient. If this were allowed to continue, it would prevent the parts adhering by first intention, and a pad of suitable size is adjusted over this region and held firmly in place with a bandage. If the temperature remains normal and the patient does not complain of pain the dressings are not disturbed for forty-eight hours, when that part of the packing extending into the nose is seized with forceps and at least a part removed. The strips of gauze at the inner and outer angles of the wound are removed wholly or partly the next day. The patient is cautioned against blowing his nose after the operation, but removes all secretions by sniffing them backward into the pharynx. After the removal of the nasal packing the nose is syringed gently once a day until healing is complete.

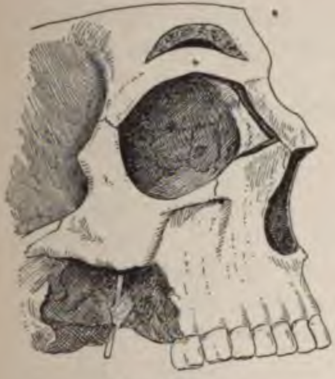

Fig. 76.

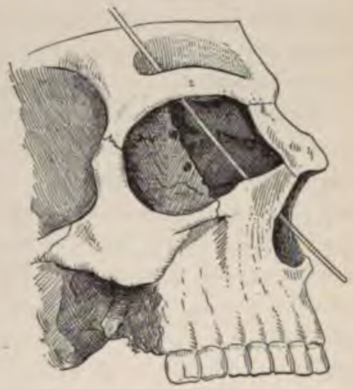

Fig. 77.

Fig. 76.—Grooves made with the **V**-shaped chisels to form the upper surface of the bridge and to outline the portion of the frontal process of the maxillary bone to be removed.

Fig. 77.—Extent of bone removed in Killian operation.

One of the dangers of the operation is that the diploë of the frontal bone become infected with a slowly advancing osteomyelitis, usually fatal. Also an external fistula may persist after healing is complete and defective vision to complete blindness as the ultimate result of orbital hemorrhage or abscess.

Mucocele of the frontal sinus is a retention cyst containing a serous exudate from the mucous membrane. The contents of the cyst are prevented from escaping by partial or complete occlusion of the ostium frontale.

Symptoms.—Pain, neuralgic in character, due to pressure caused by the accumulation. The pressure may be so great as to cause the tumor to bulge into the nose. The bone over the frontal sinus, especially the orbital portion, is painful on pressure.

Treatment.—If the cystocele bulges into the nose, it should be incised and its contents allowed to escape. When there is no bulging into the nose and an *x*-ray photograph discloses the probable presence of a fluid within the frontal sinus, one of the endonasal or even an external operation must be done.

Diseases of the Ethmoid Cells.—The most common are acute catarrh and suppuration; chronic hyperplasia, generally with polypi, and chronic suppuration generally without polypi. Hyperplasia is generally without purulent secretion and results from long-continued irritation. Pus indicates infection and hyperplasia with pus signifies both irritation and infection. Chronic suppuration usually runs its course without polypi and is generally associated with necrosis of the intercellular bony walls. It may infect the orbit, causing orbital abscess with exophthalmos; or, especially in the young, may cause meningitis, often rapidly fatal.

Pathology.—The mucous membrane of this portion of the nose extends inward to line the cells of the ethmoid. It is inseparable as a membrane from the periosteum beneath. The inflamed mucous membrane and cellular tissue, proliferating after its kind, frequently forms masses of granulation tissue and polypi.

When the deeper cells of the ethmoid are involved, the pus, instead of finding its way into the nose, sometimes breaks through into the orbit. Occasionally the anterior cranial cavity becomes infected, and an epidural abscess may exist in this location for a long time without other symptoms than slight headache and irritability of temper. A trifling cause, such as a slight intranasal operation, especially in the middle turbinate region, may spread the infection and change a latent localized meningitis into diffuse septic meningitis. Thrombosis of the longitudinal or cavernous sinus sometimes complicates ethmoidal suppuration.

Symptoms.—In chronic hyperplasia a red and swollen middle turbinate may press upon the septum. Should both turbinates be diseased, the septum is nipped between the hypertrophied bodies, and reflex rashes upon the face, tinnitus and asthenopia, or other forms of eye disease may be present. In chronic suppuration there exudes a creamy, tenacious mucus, which the patient removes from his nose with great difficulty. At this stage of the disease nasal asthma and cough or unilateral paresis of the soft palate are reflex symptoms sometimes present. There is a sensation of pressure at the root of the nose, tenderness at the inner canthus when pressure is made backward and inward toward the ethmoid. Acute ethmoiditis is occasionally an exacerbation of the chronic condition. All symptoms are exaggerated. There is pain at the root of the nose increased by pressure at the inner canthus. The middle turbinate and ethmoid is greatly swollen and covered with pus. There may be delirium at night and a sudden rise in temperature. Should symptoms of sinus thrombosis, meningitis, or orbital abscess develop, an operation should not be long delayed. Bilateral exophthalmos indicates that the infection has probably extended through the cavernous and circular sinuses and that an operation will probably not prevent pyemia or a fatal intracranial lesion.

Treatment.—The secret of success is the securing of ventilation and good drainage of the diseased area. Acute catarrhal cases recover almost spontaneously by the patient's use of an adrenalin spray at sufficiently frequent intervals, but are best treated by the daily use of a suction apparatus (page 190), followed by the injection of a 10 per cent. solution of argyrol, a few drops of which are deposited in the infundibulum and also high up above the middle turbinate by means of a hypodermic syringe whose nozzle is a fine silver cannula 8 or 9 cm. long. The fluid is often retained for an hour or more apparently by the capillary attraction of the nasal walls. In chronic suppurative cases drainage from the ethmoid cells can be greatly improved by the removal of the middle turbinate, either wholly or partly. The anterior attachment of the bone, which is nearly vertical, is severed with Beckmann's scissors (Fig. 47), and the cutting continued somewhat as far back as necessary, and the loosened portion removed with a snare. In severe cases the ethmoid cells will require removal to secure efficient drainage.

By Ballenger's method the knife (Fig. 78) is passed through the nose with the right-angled portion of the blade hanging downward until the pharynx is reached, when the knife is rotated until the right-angled part becomes horizontal. The edge of the right-angled blade is inserted posterior to the middle turbinate and, by cutting first upward and then forward, a large portion of the ethmoid, including the middle and superior turbinates, is shaved off from its attachment to the sphenoid and orbital plate. The knife is removed by rotating the right-angled part of the blade up into a nearly vertical position and is withdrawn with the severed portion of the ethmoid adhering to it.

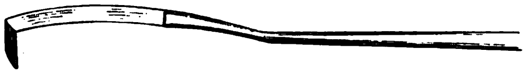

Fig. 78.—Ballenger's ethmoid knife. It is made in pairs, one for the right nostril and one for the left.

Any remains of the partitions between the cells should be removed with alligator forceps. The cell walls are thinner and more fragile than the ethmoidal wall of the orbit, and when operating it is ordinarily not difficult to differentiate between them. The lateral capsules of the ethmoid because of the conical shape of the orbits is wider behind than in front, which should be borne in mind when drawing the knife forward. However, should a portion of the orbital wall or "lamina papyracea" be removed, the exposure of the orbital fat does not delay the healing. The after-treatment consists in packing the ethmoidal region with iodoform gauze should persistent hemorrhage require it. This gauze should be removed and renewed if necessary in twenty-four hours. However, all nasal wounds heal more rapidly if the nose is not packed. The wounds should be cleansed with a syringe as often as necessary, care being taken during the first few days not to use sufficient force to cause hemorrhage.

Mosher exenterates the ethmoidal labyrinth as follows: "The anterior end of the middle turbinate is first removed. The initial plunge of the curet into the ethmoid labyrinth is best made by disregarding the agger nasi cell if it is present and going higher on the superior overhang, *i. e.*, the extreme upper part of the middle turbinate and a little further backward. If the curet does not readily break into the labyrinth, it should be carried a little higher and a little further back. This seems difficult for one not used to the method. When the curet has entered the labyrinth it is turned and swept forward until it strikes the posterior surface of the ascending process of the superior maxillary. Then it is turned so that it faces posteriorly, and by backward and downward sweeps the unciform process, the ethmoidal bulla and its cells are opened. Then all fragments of bone and shreds of tissue are removed carefully. One at this point is ready to probe the nasofrontal duct. Some difficulty may be encountered, but it usually can be found.

"The second part of the operation is carried on *by holding the head so that the cribriform plate is level.* The curet is plunged through the attachment in the middle turbinate and carried backward to the outside of the middle and superior turbinates to the front wall of the sphenoid sinus. This offers firm resistance. The face of the curet is next turned downward and the bowl and shaft forced through the bottom of the ethmoid labyrinth. This loosens the posterior half of the middle turbinate so that it can be removed. The upper third now remains and presents itself as a prominent anteroposterior ridge composed of the middle turbinate in front and the superior turbinate behind. The amount of this ridge left determines the thoroughness of the operation, and facilitates work on the sphenoid.

"Packing over night is advisable."

When an orbital abscess has formed, it may be sufficient to open it through the eyelid and use a curet until a sufficiently wide opening has been made into the nose. The pus is usually under the periosteum of the orbit posterior to the lacrimal bone, and hence in searching for pus the knife should be thrust in this direction. However, in most cases of orbital abscess it is generally better to first establish by means of *x*-ray negatives the condition of all the accessory nasal cavities of the affected side. Not infrequently the frontal or sphenoidal sinuses, as well as the ethmoidal, are involved in the suppurative process. In some cases a radical external operation is required.

The patient is etherized and the Killian incision, previously described, is made through the inner half of the eyebrow downward along the side of the nose. The periosteum is separated from the bone into the orbit and the lacrimal sac, with the periosteum beneath, lifted from the groove in which it lies. As the periosteum is being elevated still further into the orbit, generally a gush of pus indicates that the abscess has been opened and the probe readily detects necrosed bone. With a curet the lacrimal bone is removed and the anterior surface of the ethmoidal labyrinth exposed to view. When the entire lateral half of its capsule is a mass of suppurating cells, as is often the case, it should be removed, including the middle turbinate and a sufficient surface of the lamina papyracea to give room for the procedure. This is readily accomplished by tearing away the bone piecemeal with alligator forceps.

As the region of the sphenoid is approached, due care should be taken and its antrum opened or not at the discretion of the operator by removing the posterior wall of the ethmoidal labyrinth. Because of the position of the optic nerve, cavernous sinus, and internal carotid artery it is not advisable to curet the sinus or upper posterior ethmoid, but the last vestige of the cell structure should be broken down and removed with alligator forceps.

The hemorrhage resulting from the exenteration of the lateral capsule of the ethmoid is readily controlled by sponging or packing the operation cavity from time to time with strips of iodoform gauze. It is probably better in most instances at the beginning of the operation to pack the naris with a strip of iodoform gauze to prevent blood trickling into the throat; and before its removal the wound should be cleansed by syringing with warm normal solution. The wound is packed loosely with a strip of iodoform gauze, the end of which is brought out through the nostril and cut short. The skin wound is completely closed by sutures. At the end of from twenty-four to forty-eight hours the gauze packing is removed from the nose. The after-treatment consists in gently cleansing the wound through the nose with normal salt solution once a day until the parts have completely healed. In this operation and the intransal method for the removal of the ethmoid cells (p. 174) the lacrimal bone is the landmark for the position of the anterior cells. After these have been opened the septa between the others, including that between the posterior ethmoid cell and the sphenoid, are readily broken down with a curet and alligator forceps.

Empyema of the Sphenoidal Cells.—It is probable that catarrhal disease of the sphenoidal cells is of not infrequent occurrence. Generally it subsides spontaneously, and the same is true of acute suppurations if the offending bacteria are of slight virulence and the ostium remains open.

Symptoms.—Purulent discharge, seen by posterior rhinoscopy or the nasopharyngoscope, flowing from above the middle turbinate into the pharynx. Pain, said by the patient to be located in the center of the head and radiating into the ears, and probably due to the pressure of retained secretions. Ocular symptoms vary from impairment of the field of vision to complete blindness. Because of the proximity of the cavernous sinus to the lateral wall of the sphenoid, septic thrombosis or fatal hemorrhage from this vessel may occur. Within the sinus are found the third, fourth, and sixth nerves, and the first division of the fifth at the lower part of the lateral wall of the antrum. If the antrum is large it approaches the second and even the third division of the fifth nerve, and may extend sufficiently downward to approach the vidian nerve.

Any of these nerves may be involved either by an extension of the inflammation or absorption of toxins in such a manner as to produce asthenopia, paresis of one of the oculomotor muscles, more especially the superior oblique, and dilatation of the pupil. Browache may result from irritation of the first division of the fifth nerve.

The *treatment* should consist in the use of an aspiration apparatus (p. 190) and the application of alterative solutions to the mucous membrane of the upper part of the nose and vault of the pharynx by means of a syringe whose nozle is a small silver cannula (Fig. 28). This treatment will suffice for the milder cases of catarrhal inflammation which tend to recover spontaneously. However, the opening into the sinus is as readily entered by the cannula as by the probe, as described below. The sinus may be cleansed with normal salt solution and 10 per cent. argyrol injected and allowed to remain.

The ostium of the sphenoid is usually located in the upper third, practically always in the upper half of its nasal wall, except when an ethmoid cell lies directly over the antrum. From a surgical standpoint such a conformation may be regarded as an antrum divided horizontally into two apartments, each with its ostium. That of the antrum proper will be much lower than normal, while above anteriorly is that of the ethmoid cell.

The ostium usually lies deep in the sulcus between the sphenoid and the ethmoid cells, and is completely hidden from view by the posterior border of the middle turbinate. After thorough cocainization, it can sometimes be exposed by inserting Killian's speculum (Fig. 14) between the septum and the middle turbinate. When the antrum is suppurating, a pulsating drop of pus will sometimes be seen protruding from the ostium.

If a straight probe (Fig. 76) is passed over the exact center of the middle turbinate it will strike the anterior wall of the sphenoid (Zuckerkandl's line) generally sufficiently near the ostium for it to be found by gently manipulating the probe in various directions, but more especially laterally. It may be necessary to slightly bend the very end of the probe so that it will penetrate more deeply into the spheno-ethmoid sulcus before the ostium is located.

The distance from the anterior, inferior nasal process to the sphenoid ostium is rarely over 7½ mm. even in large heads; so that if a probe passes along Zuckerkandl's line for a distance of from 8 to 10 cm. it may be assumed to have entered the antrum. Generally the probe enters the antrum with a little jerk, as if a slight resistance had been overcome, because the bone about the ostium is very thin and its immediate edge consists only of mucous membrane. In suppurative cases when the probe is withdrawn from the antrum its end will have a fetid odor.

Should this method of probing the sinus prove a failure, the thin anterior wall of the sinus can be penetrated by means of Grayson's guarded drill and the opening enlarged with a curet or punch forceps.

In operating, care should be taken not to injure the upper wall because on it lies the optic nerve; nor the lateral wall because of the proximity of the cavernous sinus with the internal carotid passing through it. Because of dehiscences in the bone either the nerve or the sinus may be covered only by mucous membrane. Should the cavernous sinus be wounded the hemorrhage will be profuse. The operator should at once introduce the forefinger of the left hand behind the palate and endeavor to insert its tip into the antrum or at least temporarily close the instrumental opening in its anterior wall with his finger-tip. A strip of iodoform gauze is then carried through the nostril by means of a pair of forceps and packed into the antrum. This will control the hemorrhage. Douglass, who recommends this method, states that the gauze should not be interfered with before the third day, and then removed slowly and with great gentleness and caution.

The after-treatment consists in simply cleansing the parts with normal salt solution and preventing the premature closing of the opening into the antrum. In most cases the mucous membrane of the antrum quickly assumes a normal appearance if there are no retained secretions.

Accidents and Danger of Operations on the Accessory Cavities.—The region of the supra- and infra-orbital foramina should be respected as far as the exigencies of an operation will permit; although cutting the nerve in either locality produces no greater disaster than a feeling of numbness and slight discomfort which may persist for years. The lifting of the lacrimal sac from its groove should be done with sufficient care to avoid tearing the sac and the nasal orifice of the duct should be avoided if possible. However, it is difficult to understand why simple resection of the duct at its inferior portion during a Caldwell-Luc operation should lead to infection of the duct and stricture, but this sometimes occurs and necessitates probing and medication or the wearing of a style. Injuries of the orbit through the nose are sometimes attended by disastrous results. In such cases a puncture, because of the lack of proper drainage of the orbit, becomes infected and is more dangerous than the removal of a considerable portion of its bony wall, as in a Killian operation. Figure 67 shows how readily the orbit might be punctured when the needle is thrust through the middle meatus, when the antrum is small. Douglass observed a case where the antrum was greatly narrowed by a curious guttering of the orbital floor to the extent that the orbit might readily be punctured by a needle thrust beneath the inferior turbinate in the usual position. In a case reported by Seaman, washing the antrum through the alveolus with 1 : 2000 bichlorid solution resulted in infection of the contents of the orbit including the optic nerve. Vision in both eyes was ultimately lost. The same author relates an instance where an operation in the ethmoid region was followed by hematoma of the orbit, exophthalmos, and ultimate blindness with divergence. However, the prognosis as far as permanent injury to the eye in orbital hemorrhage is concerned is good when prompt measures are taken to relieve injurious pressure. The same remark applies to the accidental injection of a moderate amount of sterile normal salt solution into the orbit. In cases where emphysema of the orbital tissues results from fracture of the orbital plate of the ethmoid, the prognosis is also good. The only treatment necessary being a light pressure bandage and the avoidance of sneezing and blowing the nose.

The danger of osteomyelitis after the Killian operation has been alluded to. If in an operation upon the accessory sinuses the dura is exposed, the same rules apply as in mastoid operations. The exposure should be made sufficiently large to afford ample drainage. If the dura is accidentally punctured it should be incised through the puncture to the extent of ½ inch, as such wounds are less likely to cause meningitis than punctures.

Reference has been made to danger of cureting the sphenoid antrum because of the proximity of the optic nerve and great blood-vessels. However, cureting the upper portion of the lateral wall of the most posterior ethmoid cells is also dangerous, and even unnecessary probing of this region should be avoided.

The greatest objection to most radical operations on the nasal accessory sinuses is the enormous amount of mucous membrane destroyed and replaced by cicatricial tissue. Hence all unnecessary cureting and destruction of mucous membrane should be avoided; for it should be borne in mind that no matter how greatly swollen and inflamed the mucous membrane of any of the sinuses, unless covering necrosed bone, it will finally assume nearly normal functions under favorable circumstances of drainage and ventilation. The fact that the ethmoid labyrinth because of its cellular arrangement is a good non-conductor, and hence must protect the orbital and cranial contents from cold inspired air, also may help to explain the discomfort complained of by some individuals after radical operations on the accessory sinuses. In some instances the discharge, for which the operation was mainly undertaken, never entirely ceases; probably because of the difficulty or impossibility in some cases of exenterating completely the so-called orbital, frontal, antral or sphenoid, ethmoid cells that so often occur. In some instances drainage from what remains of the ethmoid cells after a Killian, Ballenger, or Mosher operation is apparently made worse rather than better by the operation. Hence the tendency is toward conservatism; some formerly enthusiastic operators claiming that in the majority of cases better end-results are obtainable by treatment, especially treatment by suction, than by radical operations.

Treatment of Suppuration of the Accessory Nasal Sinuses by Suction.—Any apparatus that will quickly produce a partial vacuum within the nose will answer the purpose for treatment; but it should be of sufficient capacity to allow a certain amount of leakage about the nose-piece and still maintain negative pressure within the nose. It should be provided with a regulator and gage by which the exact amount of suction can be controlled. The gage (Fig. 29) is usually marked from 1 up to 30; and each division represents the weight of an inch of mercury; so that if the gage stands at 30, it indicates that approximately a perfect vacuum is being maintained; because the height of a column of mercury in a barometer that the pressure of the atmosphere will sustain is only about 32 inches. However, a negative pressure within the nose and accessory sinuses of much over 20 inches of mercury is often painful and usually causes hemorrhage by the suction of blood from the inflamed mucous membrane. The use of a suction apparatus produces two results. In the first place it empties a sinus more or less completely of any mucus or pus it may contain. This is best accomplished by a remittent action of the apparatus, that is, the suction is continued only for a moment when air is admitted into the nose and immediately aspirated, and the process continued until secretions cease to be drawn from the sinus. However, the most important effect of the suction in chronic cases is the production of hyperemia, which is best secured by maintaining a partial vacuum steadily for ten or fifteen minutes.

The nose-piece is moistened and inserted into one nostril of the patient in such a manner as to make an air-tight joint, and the other nostril closed by the finger of the operator. A vacuum within the nose results when the posterior nares are closed by the elevation of the soft palate. This either occurs spontaneously or is brought about by the patient saying "Ka." The patient, of course, breathes through his mouth while the vacuum is maintained within his nose. He can talk if he wishes to, but because the palate is elevated and motionless his voice has a somewhat nasal tone. Many patients soon learn to manipulate the nose-piece of the apparatus themselves, and thus allow the operator to give his attention to other matters about the office. It should be noted that the action of the suction apparatus is a sort of vacuum cleansing of the affected sinuses combined with Beals' artificial congestion treatment. Air can be admitted instantly into the nose by simply taking away the operator's finger from the nostril not occupied by the nose-piece of the apparatus.

In acute cases pain and headache disappear in a great measure after the sinus is simply emptied of the pus or mucus it contains. In some cases this does not re-collect, while in others several daily treatments are necessary to bring about a cure. In most chronic cases headaches and impaired vision begin to improve after one or two sittings, and even before the quantity of mucopus removed from the diseased cavity has noticeably diminished. At first bloody and purulent, under favorable circumstances the discharge soon assumes the appearance of transparent, thin mucus, becoming less and less until it finally disappears entirely. For obvious reasons daily treatments in most cases yield the best results, and may be combined with any operative procedure that will improve drainage from the diseased cavities; but in most instances these are not required to bring about a cure, at least for the time being, of the suppuration.

THE PHARYNX

ANATOMY OF THE PHARYNX

THE pharynx is a conic, musculomembranous bag suspended base up from the basilar process of the occipital bone. It extends downward to the lower border of the cricoid cartilage and fifth cervical vertebra, where it merges into the esophagus. It is composed of three layers—an inner, mucous; a middle, fibrous, sometimes called the pharyngeal aponeurosis; and an outer, muscular layer.

At birth the nasopharynx is nearly as long anteroposteriorly as in the adult, but is relatively very low, being merely a narrow passage, running backward and downward from the constricted posterior nares. Consequently, the soft palate is more horizontal than in the adult. The height of the nasopharynx increases with the development of the posterior nares. At birth their height is from 6 to 7 mm. and the breadth between the pterygoid process about 9 mm.

For the first six months the height of the nasal passages increases rapidly to double the size at birth, after which the increase is relatively slow. The nasopharynx is very vascular, with an abundant supply of lymph-glands, so that its lymphoid ring is well developed at birth.

Relations of the Pharynx.—Posteriorly the pharynx is connected by loose cellular tissue with the first five cervical vertebræ (Fig. 64), the first, or atlas, forming a promontory extending forward into the pharynx on a level with the palate. On each side posteriorly are the longus colli and recti capiti antici muscles. Laterally are the styloid processes with their muscles, the internal carotid arteries, the internal jugular vein, the eighth, ninth, and sympathetic

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nerves. Near its apex are the lobes of the thyroid gland, the common carotid and lingual arteries, the lingual nerves, and the sternohyoid muscle.

Divisions.—The pharynx is divided into the nasopharynx, sometimes called the posterior nasal space, the oropharynx, and laryngopharynx. The nasopharynx extends downward to the edge of the soft palate, the oropharynx from this to a line drawn through the cornua of the hyoid bone, and the laryngopharynx the rest of the distance to the commencement of the esophagus at the fifth cervical vertebra.

Attachments.—The pharynx is attached to the internal pterygoid plate, pterygomaxillary ligament, inferior maxillary bone, base of the tongue, cornua of hyoid bone, stylohyoid ligament, and the thyroid and cricoid cartilages.

Muscles.—There are seven muscles—the superior, middle, and inferior constrictors, two stylopharyngei, and two palatopharyngei muscles. The latter, covered by mucous membrane, form the anterior pillars of the fauces, the stylopharyngei, the posterior pillars. A not very uncommon anatomic peculiarity is that one or both the palatopharyngei are completely surrounded by mucous membrane, so that a probe can be passed between them and the rest of the outer wall of the pharynx.

Arteries.—There are four arteries supplying the pharynx —two branches of the external carotid and two branches of the internal maxillary. These are the ascending pharyngeal and branches from the superior thyroid; descending pharyngeal and pterygopalatine. Occasionally arteries as large as the radial are seen pulsating on either side beneath the mucous membrane of the pharynx. These are supposed to be displaced occipital arteries.

Nerves.—The pharynx is supplied by a plexus composed of branches from the pneumogastric, glossopharyngeal, superior laryngeal, and the superior cervical ganglion of the sympathetic.

The **mucous membrane** of the nasopharynx is covered with stratified ciliated columnar epithelium, the oropharynx with squamous epithelium, and the laryngopharynx with squamous posteriorly, and ciliated epithelium anteriorly. There are simple follicular glands, compound follicular, and racemose glands.

Tonsils and Lymphatics of the Pharynx.—The laryngopharynx has few or no lymphatics. Above the supply is profuse, being located mainly in the mucous membrane of the superior and posterior wall.

The tonsils are a part of an irregular ring of adenoid tissue surrounding the pharynx and continuous with the general lymphatic system. There are seven tonsils: two faucial, two tubal, two lingual, and the pharyngeal. The faucial tonsils are situated one on each side of the fauces between the anterior and posterior pillars of the fauces. The lingual tonsils are situated at the base of the tongue, the tubal tonsils at the pharyngeal eustachian orifices, and the pharyngeal tonsil in the vault of the pharynx posterior to the nasal orifices. Any of these tonsils when hypertrophied may cause annoying symptoms, but the lingual tonsil is more apt to prove troublesome after middle life if at all, while hypertrophy of the faucial and pharyngeal tonsils are generally diseases of childhood.

The faucial tonsils are oblong in shape with their long axis vertical. At birth they are $\frac{1}{5}$ to $\frac{2}{5}$ inch long and $\frac{1}{10}$ to $\frac{1}{5}$ inch wide. The tonsils develop in size up to the sixth or eighth year, when they are 1 to $1\frac{1}{4}$ inches long, $\frac{3}{5}$ to 1 inch wide, and from $\frac{3}{5}$ to 1 inch in thickness. They are frequently swollen without infection during the eruption of teeth at the *second*, *sixth*, *twelfth*, and *seventeenth* years, and carious teeth probably are frequent causes of tonsillar infection. The tonsils consist of lymphoid masses held together by a trabecula of connective tissue containing the vessels and nerves, and are surrounded, except on the free surface, by a capsule or sheath. The faucial surface is covered by an extension of the adjacent mucous membrane, with its stratified epithelium extending inward to line the crypts.

Above the tonsils and between the anterior and posterior pillars is situated the triangular *fossa supratonsillaris*. Here a number of crypts extend vertically into the tonsil, the retention of whose excretions plays an important rôle in the production of peritonsillar abscess. The number of crypts, both vertical and horizontal, rarely exceeds fifteen for each tonsil. They vary in length from ¼ to ¾ inch or even more in tonsillar hypertrophy (Fig. 84). The anterior lower third of the tonsil is often covered by the hyperculum plica triangularis, a triangular fold of mucous membrane extending from the anterior to the posterior pillars downward and backward across the tonsil. This fold when large may interfere with the drainage of the crypts it covers or form a pocket of retained secretions. It should be removed with the tonsil in tonsillectomies. Its anterior, inferior border usually is firmly attached to the tonsil, anterior pillar, and base of the tongue when cut from the anterior pillar, it permits the tonsil to be drawn toward the median line of the pharynx away from the pillar and opens the cellular space external to the capsule for the introduction of an enucleation instrument. Removal of the plica separates the tonsil from its attachment to the anterior pillar and tongue and hence permits freer movement of the parts.

When diseased, the crypts sometimes branch and communicate with each other in such a manner as to retain lymph and epithelium cells; so that cholesteatomatous masses collect whose decomposition imparts a fetid odor to the breath. The faucial tonsils drain into the deep lymphatics of the neck, so that systemic infection may occur by way of the thoracic glands and duct, or the apex of the lung may be, it is said, infected with tubercle bacilli from the tonsil by way of these glands.

The tonsils themselves lie too deep to be felt through the skin of the neck and, according to Wood, the deep lymphatic or "tonsillar gland," into which the tonsil empties, lies external and slightly anterior to the internal jugular vein. Hypertrophy of this gland means its dislocation outward and forward, but generally it can be pushed back beneath the sternomastoid muscle, which is not the case with hypertrophied superficial lymphatics. Chronic inflammation of the tonsils usually causes palpable enlargement of the deep cervical lymphatics.

According to Deaver, the tonsils are supplied with blood from the ascending pharyngeal branch of the external carotid, the tonsillar and ascending palatine branches of the facial artery, the dorsalis lingua branch of the lingual artery, and the descending palatine branch of the internal maxillary artery. Externally, the tonsil is separated from the internal carotid and the ascending pharyngeal artery by the superior constrictor muscle and the pharyngeal aponeurosis. Of these vessels the ascending pharyngeal is the more apt to be injured by operations for the removal of the tonsil, because it lies directly opposite the tonsil on the external surface of the superior constrictor. Malignant growths of the tonsil are best removed through an incision made parallel to the anterior border of the sternomastoid, because the involved lymphatics cannot satisfactorily be removed through the mouth. The line of incision for ligation of the external carotid is parallel to the anterior border of the sternocleidomastoid muscle, from the angle of the jaw to the cricothyroid membrane. Working from below upward by dry dissection the superior thyroid artery is soon encountered, which serves as a guide to the external carotid, and should be tied below the origin of the ascending pharyngeal, which means as close to the junction of the external and internal carotids as possible. However, in operations upon the tonsils it is usually the veins and not the arteries that cause troublesome hemorrhage. There are two large veins, one close to the anterior lateral border of the tonsil behind the anterior pillar and the other close to the posterior lateral border behind the posterior pillar. Both are in the cellular tissue external to the capsule and are usually avoided in tonsillectomies, but when either is torn or cut the hemorrhage is profuse, but usually readily controlled by digital pressure through a gauze sponge.

The *functions* of the tonsils are similar to those of other lymphatic glands. As a part of the hemopoietic system they form young lymphocytes, most of which pass into the circulation, but some escape to the free mucous surface, and carry off with them effete products.

The tonsils are most active during youth, while the thymus, a large blood-forming gland, is atrophying. There is considerable difference of opinion as to the phagocytic action of the tonsils, some authorities claiming that the tonsils constitute a weak part of the throat and expose the system to the inroads of diphtheria, tuberculosis, syphilis, acute articular rheumatism, and other diseases.

In evidence of the difference in the behavior of tonsillar epithelium toward dust and bacteria, Jonathan Wright dusted carmin over the tonsil. Fifteen minutes later all the particles of carmin had passed through the epithelium into deeper layers and could be detected in sections under the microscope; while bacteria, situated at the exact point where the carmin entered, remained quiescent and unabsorbed.

Good has endeavored to prove that the chief function of the tonsils is to establish immunity to infection especially early in life. Secretions from the nose are carried toward the tonsillar crypts as demonstrated by Jonathan Wright. Secretions from the lungs are coughed or carried toward the tonsils, and in vomiting the contents of the stomach are brought directly in contact with the tonsils. Hence bacteria that have entered the mouth or nose are directed toward the tonsillar crypts, which are lined with stratified epithelium and the mucus within them serves as a culture-medium for the development of vaccines which enter the lymph-current of the tonsil and are carried into the entire system, where they come into contact with the fixed cells and excite them to produce antibodies such as opsonins, agglutinins, etc., and thus produce immunity. Until immunity is established the lymphocytes of the tonsillar secretions have no great affinity for bacteria which consequently flourish; but when immunity is established for the variety of bacteria within the crypts, their secretions contain opsonins and hence the lymphocytes attack the bacteria and destroy them by phagocytosis. In the act of deglutition the tonsils are squeezed by the superior constrictor and their contents emptied into the pharynx. Agglutination and bacteriolysis can also take place in the tonsils. Their interfollicular connective tissue is composed of interlacing fibers whose interspaces are filled with lymphocytes and polynuclear leukocytes which offer every protection to the general system from bacteria that pass through the epithelium of the crypts: so long as the tonsillar functions are not so altered by disease as to render the tonsils a possible portal for systemic infection, and not a protection.

According to the experiments of Ott and Scott, injection of an extract of powdered tonsil into an animal produced at first a great fall in blood-pressure, followed by a rise above normal, and a slower and stronger heart-beat. The amount of urine is also increased many times the normal amount.

DISEASES OF THE NASOPHARYNX OR POSTNASAL SPACE

Postnasal catarrh may be either secondary, as when a nasal accessory sinus discharges into the postnasal space, or the disease may be primary, and extend to either the nose or eustachian tubes. The nasopharynx may be blocked by posterior hypertrophies of the turbinated bodies or by polypi, cysts, fibroid tumors, or malignant growths springing from the posterior nares or from the vault of the pharynx. A somewhat common affection beginning generally in childhood is hypertrophy of the pharyngeal or Luschka's tonsil.

Adenoid vegetations or **hypertrophy of the pharyngeal tonsil** is an overgrowth of the normal adenoid tissue of the pharyngeal vault. The affection is often associated with hypertrophy of the faucial tonsils, and generally commences in childhood, but may be met with in patients of any age.

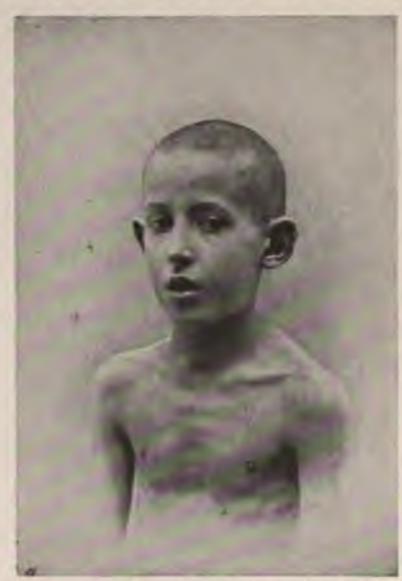

Fig. 79.—Typic appearance in adenoid vegetations: boy ten years old (Frühwald).

Symptoms.—If the adenoid vegetations are at all large they block up the posterior nares and compel mouth-breathing, the pinched nostrils and half-open mouth giving the face a vacant and well-nigh idiotic expression (Fig. 79), which ordinarily disappears as soon as nasal respiration is reestablished. However, if mouth-breathing be continued into adult life permanent deformity of the bones of the face and even of the chest results. Breathing is audible sometimes during the day and there is always loud snoring during sleep. The voice is toneless, articulation is indistinct, and the hearing is often impaired.

Treatment.—Adenoid vegetations tend to no longer obstruct nasal respiration as the individual passes into adult age and the nose and nasopharynx grows larger, but may, in the meantime, have produced irreparable injury to the ears and altered the shape of the bones of the face. Application of Formula 111 to the postnasal space will sometimes bring about a slow absorption of the hypertrophied tissue. In children, when the growth is not large, such applications should be made by the surgeon two or three times a week, the parents in the meantime cleansing the nose night and morning with the spray from an atomizer containing an alkaline wash and afterward placing in each of the child's nostrils a mass the size of a pea of gallic acid ointment 5 to 10 grains to the ounce of vaselin. The child should then lie on its back for a few moments until the ointment melts and runs into the nasopharynx. However, the only treatment adequate in the majority of cases is a thorough removal of the mass by surgical procedures. In adults postnasal cutting forceps (Fig. 80) may be used; the operator being careful to begin operating in the median line, and working from it in each direction until the entire mass is cut and torn away from its attachment, at the same time being careful not to wound the orifices of the eustachian tubes.

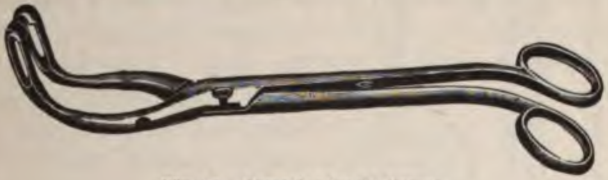

Fig. 80.—Juracz's adenoid forceps.

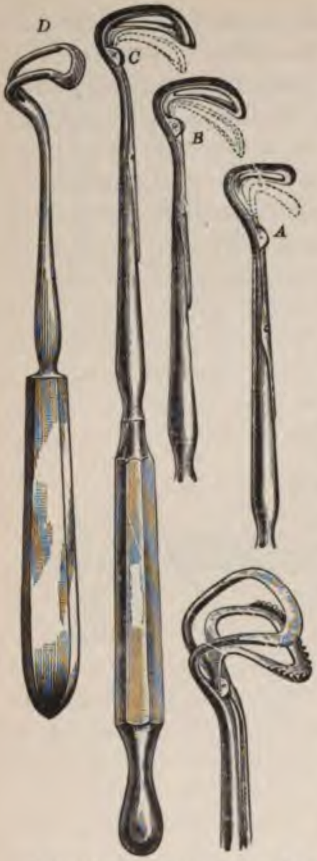

Fig. 81.—Adenoid curets. The original Gottstein curet was designed for scraping rather than cutting. The improved form is shown at *D*, whose cutting edge should be kept sharp in order to easily sever the growth. Fetterolf's modification, *A*, *B*, *C*, consists in the attachment of a spring clamp, serrated in such a manner as to firmly grasp all adenoid tissue cut from the pharynx. The set consists of three, with varying angles to the blade and different lengths of crura, in order that no matter what the shape of the pharynx or the situation of the growth it can be reached and removed by one of the instruments.

In children or in adults, when the pharyngeal tonsil is still comparatively soft, a curet (Fig. 81) is a most efficient instrument. Young children should be seated in the lap of a nurse upon a piano stool opposite the operator, in the same manner as for an ordinary examination of the nose and pharynx. The nurse passes her arms beneath those of the child and places her hands, one on each side of the child's forehead, in such a manner as to control the movements of the head. The nurse then elevates her elbows so as to bring the child's arms into such a position that it is impossible for the child to reach its mouth with its hands. The curet is now passed behind the palate, and the handle of the instrument depressed until the outer edge of the ring is felt to rest against the septum. By sweeping the ring upward, backward, and downward against the pharyngeal wall the growth is brought within the curet and is cut from its attachment. Without removing the instrument from the mouth the maneuver is quickly repeated at each side of the median line in order to be certain that the major portion of the growth has been removed. The operation should be performed quickly, but with gentleness, little force being required to sever the growth from its attachment.

The nurse then releases the child's head, and the operator passes his left arm around the child's head and thrusts his forefinger hard against the child's cheek, in such a manner that the cheek protrudes between the child's open jaws, so as to form an efficient mouth-gag. The operator then quickly passes the forefinger of his right hand behind the child's palate until the posterior edge of the septum is felt. The posterior nares, Rosenmüller's fossæ, and the vault of the pharynx are inspected, as it were, by the sense of touch. If any shreds of the growth remain they are removed with the finger-nail, scraping them from below, upward, and forward. Before removing his finger the operator should spare no pains to assure himself by the sense of touch not only that nothing remains to obstruct nasal respiration, but that Rosenmüller's fossæ are freed from any mass likely to interfere with the blood-supply of the eustachian tubes. The hemorrhage following the operation is generally trifling and the after-treatment consists in simply keeping the parts clean with an alkaline wash.

When a general anesthetic is employed it should be ether and not chloroform, because in this condition, the so-called "habitus lymphaticus" of Kalisco, chloroform is especially dangerous, somewhat numerous deaths having been reported.

Ether is not necessary to secure an adequate removal of the hypertrophy. However, the major portion of successful operators prefer to operate under ether, stating that the operation then can be done more deliberately, and there is less danger of failure to remove all portions of the hypertrophy.

The patient's mouth is opened widely with a mouth-gag in the hands of an assistant, and the operator carefully explores the nasopharynx with his forefinger to ascertain its shape and the size and attachment of adenoid tissue. The finger is then removed from the mouth, the tongue held down with a tongue depressor, and a suitably shaped guarded curet (Fig. 81) inserted in such a manner that its blade glides along the posterior border of the septum and encircles the adenoid mass, which is cut away and held by the serrated spring as the blade sweeps upward, backward, and downward in close contact with the nasopharyngeal wall. The operator's forefinger is reintroduced behind the soft palate and shreds of adenoid tissue are either rubbed away with the finger-tip covered by gauze or, if large, grasped with the forceps (Fig. 80) and cut away. The finger-tip should be inserted into each posterior naris and every pains taken to detect little shreds of adenoid tissue that have escaped the curet because of their anterior position, and which, if allowed to remain, will greatly impair the success of the operation. In aural cases the surroundings of the eustachian prominences should receive especial attention, and masses of adenoid tissue still remaining in Rosenmüller's fossæ should be carefully rubbed away with the finger-tip or removed with the forceps.

Some operators prefer to remove the entire adenoid mass with forceps, which are introduced closed behind the soft palate. The biting tips are then opened and forced upward against the vault of the pharynx, the handles brought into contact with the patient's upper teeth, the blades pushed backward against the posterior wall of the pharynx and closed about the growth, which is removed with a downward and outward pull. The forceps can be reintroduced as often as necessary to remove the entire mass, but it is important that the handles should be kept in contact with the patient's upper teeth, for the curve of the forceps is such that otherwise the posterior edge of the septum will be grasped.

When operating under ether the foot of the operating table should be elevated about 3 inches and the patient should lie upon his left side with the arm and the shoulder of that side drawn behind and under him, so that the head readily can be rotated downward in order that the blood may flow from the mouth and not enter the larynx. Ordinarily pools of blood and clots collect in the hollow of the left cheek, which requires mopping out, especially if the tonsils have been excised preliminary to the removal of the adenoids. From the third tonsil most of the hemorrhage escapes from the nasal passages, and for a moment is abundant, but quickly subsides. Should this not be the case, a small gauze sponge in the grasp of a curved hemostat should be passed up behind the palate and pressure maintained upon the bleeding spot until the hemorrhage ceases.

Under ether cutting forceps are safer than an operation with the ordinary curet, because the portions of tissue severed by the forceps are removed in the grasp of the instrument, so that they cannot be inspired into the larynx. However, good operators, in their desire to do a "thorough" operation, have bitten off with the forceps portions of the posterior edge of the vomer or even of the soft palate, and it is safer, unless the operator has great experience, not to introduce the forceps unless guided by the forefinger of the left hand inserted behind the palate, so that he may be certain that neither the posterior edge of the vomer, the soft palate, nor one of the eustachian tube mouths enter between the cutting blades of the forceps, and the operation should not be so "thorough" as to expose the fibrous tissue overlying the vertebra or tear loose a portion of the upper border of the superior constrictor of the pharynx. It is a good plan to insert the left forefinger into each choanæ and strip the adenoid mass downward and backward from the pharynx so as not to leave a fringe of its upper border when the operation is completed.

The improvement in nasal respiration and in pronunciation following the operation is immediate and pronounced; and if hearing was impaired as the result of interference with the function of the eustachian tubes, the acuteness of hearing rapidly improves after the operation. In adults the reaction from the operation is but trifling. However, children sometimes complain for a few days that the throat is sore and that it hurts them to swallow.

Sometimes a considerable time elapses after the operation before a young child can be taught to breathe entirely through his nose. Of course, in cases where mouth-breathing is the result of other causes than adenoids, removal of the third tonsil does not secure nasal respiration, and before resorting to an operation, which may be unnecessary, the surgeon should bring about a cure of any nasal catarrh that is present. In cases where, as a result of a faulty position of the teeth or malformation of the jaws, the lips do not come together when the child's face is at rest, it will be necessary to correct the dental deformity as well as remove adenoids to secure nasal respiration and a symmetric development of the bones of the face. In individuals between five and twenty-five years of age, if there is a fair amount of nasal respiration, the faulty position of the teeth should be corrected before any nasal operation is undertaken, but if nasal respiration is greatly impaired, operations on the air-passages sufficient to secure nasal breathing should be done before regulating the teeth.

Thornwaldt's Disease or Chronic Bursitis.—The bursa of the pharyngeal tonsil was described by Luschka, and chronic inflammation of this structure was later elucidated by Thornwaldt, after whom the disease has been named.

Symptoms.—When chronically inflamed the bursa of the third tonsil secretes a considerable amount of thick, tenacious mucus, globular masses of which may be hawked out by the patient from the pharynx several times a day. There are no other subjective symptoms in uncomplicated cases. The bursa is discernible and may be explored to a variable depth by means of a probe suitably bent.

Treatment.—The consensus of opinion seems to be that a permanent cure can only be effected by the radical destruction of the bursa by means of the galvanocautery or some other method, a difficult matter to accomplish because of the anatomic situation of the bursa. However, almost complete cessation of the discharge, for the time being at least, can be brought about by thorough cleansing of the parts and applications to the interior of the bursa, by means of a cotton-tipped probe, of a 12 per cent. solution of nitrate of silver at sufficiently frequent intervals.

DISEASES OF THE OROPHARYNX

Acute tonsillitis is an inflammation of the tonsils and adjacent structures. There are two common varieties—the croupous and the phlegmonous.

Acute follicular tonsillitis or **croupous tonsillitis** is an inflammation of the tonsil, originating in the crypts and accompanied by the formation of a pseudomembrane which, at first confined to the neighborhood of the crypts, often extends over the entire tonsil or tonsils. Occasionally the pharyngeal or lingual tonsils are involved or the disease may occur in these structures independently.

Etiology.—This disease is the result of infection, but is contagious only to a very limited degree. It is an inoculation of the tonsils with bacteria capable of producing a croupous pseudomembrane, the most common of such bacteria being the streptococcus and staphylococcus. Probably exposure to cold and an excess of uric acid in the blood are predisposing causes. Occasionally cases of croupous tonsillitis are followed within a month by acute articular rheumatism, and it is maintained that the tonsils are the points at which the bacteria causing the rheumatism find entrance into the system.

Pathology.—The brunt of the inflammation is borne by the crypts of the tonsils, which pour out an abundant fibrinous secretion, which, adhering to the surface of the tonsil, presents somewhat the appearance of a diphtheric membrane (Figs. 82 and 83). The membrane consists largely of necrotic epithelial cells, and does not involve the deeper tissues. The tonsils are somewhat swollen and the entire pharynx is inflamed.

Diagnosis.—In typic cases occurring in *adults* there is usually no difficulty in distinguishing by the unaided eye the difference between such a membrane and the more yellow, thicker, and sometimes seminecrotic membrane of diphtheria. The croupous membrane is thin, white, perhaps opalescent, and can somewhat readily be wiped away a small piece at a time, by means of a cotton-tipped probe. Ordinarily it does not extend beyond the tonsils.

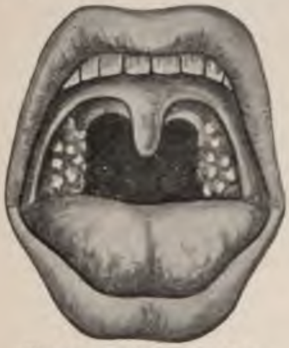

Fig. 82.—Follicular tonsillitis.

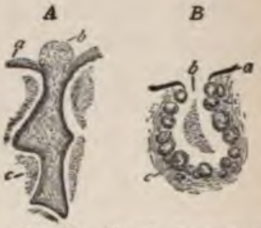

Fig. 83.—Crypts in cases of tonsillitis: *A*, Acute lacunar; *B*, chronic hypertrophic; *a*, surface epithelium; *b*, accumulated contents of crypt; *c*, lymphoid follicles surrounding crypt. (Kaufmann.)

However, in the case of young children diagnosis by the unaided eye between the two affections is by no means easy. The struggles of the child allow only a momentary glance at the parts, and for the same reason some bleeding may occur in the effort to remove a part of the membrane. Occasionally a thin opalescent patch occurs upon the anterior pillars or elsewhere in the neighborhood of the tonsil, whose appearance is very deceptive.

In no case can an *absolutely positive diagnosis* between croupous tonsillitis and diphtheria be made without the aid of a competent bacteriologist, whose investigations shall not only consist of the examination of smears and culture tests, but also inoculation experiments, to exclude Hoffman's bacillus, which closely resembles in all respects, except virulence, the Klebs-Löffler bacillus.

Mucous patches upon the tonsils and the superficial ulcer of tertiary syphilis have sometimes been mistaken for croupous tonsillitis, but ordinarily the diagnosis is easy.

Symptoms.—There is often a chill, then dryness and stiffness in the throat, soon followed by dysphagia. There is tenderness on pressure over the lymphatics of the neck, which may be somewhat swollen, but never to the extent seen in diphtheria.

Ordinarily the temperature is higher in croupous or follicular tonsillitis than in diphtheria, but some cases, after a temperature of 103° F. or thereabouts for the first twenty-four hours, assume the characteristic lower temperature of mild diphtheria.

Rare in the adult, at least a croupy cough is to be expected in young children with follicular tonsillitis, and sufficient laryngeal stenosis to require intubation is not impossible.

Typical cases run a course of about five days and end in recovery.

Treatment.—In the case of adults the writer has aborted follicular tonsillitis by the following method: Each affected crypt was in turn washed out with hydrogen peroxid, by means of a Blake's middle-ear cannula screwed on to a hypodermic syringe. The curved tip of the cannula employed is about ½ inch in length and capable of reaching to the bottom of the follicle. Only a drop or two of the peroxid is injected at one time, but the process is repeated until all of the exudate has disappeared. A fine Allen probe with a few fibers of cotton wrapped about its end is then bent to an appropriate angle, and, after being dipped into a 12 per cent. solution of nitrate of silver, is carried to the bottom of a follicle, and the process repeated until each of the affected crypts has received the silver solution. The surface of the tonsil is then painted with the same solution. The treatment is followed immediately by a sense of relief and comfort, and the difficulty in swallowing is in a great measure alleviated. The process may be repeated two or three times a day, and in successful cases brings about a cure at the end of the second or third day.

In cases of children or in adults,when as the result of timidity or excessive irritability of the fauces this method is not applicable, spraying the parts with hydrogen peroxid and the application of a 12 per cent. solution of nitrate of silver suffices for the local treatment. A 12 per cent. solution of silver carefully applied to the tonsils occasions little or no discomfort in health, and when the mucous membrane of this region is inflamed the solution acts as a sedative and its application is followed by a sense of relief and comfort. This, however, is by no means true of the mucous membrane covering the posterior wall of the pharynx, and care should be exercised not to irritate it by the application of the silver solution.

The patients if seen early in the attack should be purged, preferably with calomel; and if the temperature is high and the discomfort great, relief follows drop doses of tincture of aconite combined with 1 or 2 grains of aspirin every hour for six or eight hours. A simple astringent gargle or a lozenge of guaiac and tannin may be prescribed (Formula 64), or the patient may spray his throat every hour with a solution of alumnol. Keefer treated 60 cases in the military hospital at Fort Russell, Wyoming, by spraying the throat with a saturated solution of sodium bicarbonate three times a day, immediately followed by the liberal application of finely powdered acetyl salicylic acid (aspirin). The results were that the tonsils became blanched and the patients entirely comfortable within twenty hours, with an average duration for the disease of three days. No case so treated was followed by articular rheumatism. In another series of 60 cases treated by the usual methods the average duration of the disease was six days, and 9 cases (15 per cent.) developed subsequently acute articular rheumatism. No cases were apparently benefited by aspirin *internally*.

Focal Infection.—More than thirty diseases are said to sometimes result from infection derived from a focus located in acutely or chronically inflamed tonsils. Acute follicular tonsillitis is *occasionally* followed by acute articular rheumatism, but is not the *usual* cause of that disease, as anyone can satisfy himself by questioning the patients with acute articular rheumatism in the wards of a hospital. Few or none give a history of *recent* attacks of tonsillitis; but it is not rare to patients who many years before had recurrent attacks of tonsillitis, none of which were followed by rheumatism. Both in acute and chronic infections of the tonsil it is not unusual to find the same bacteria in chronic infections about the teeth; so that it would seem that the mouth and not the tonsils was the original focus of infection. The accessory sinuses, teeth and ear, as well as the tonsils may be sources of focal infection.

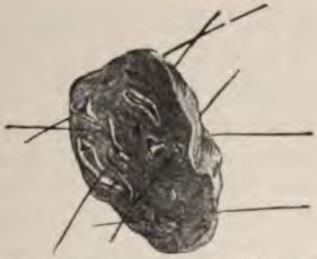

Fig. 84.—Posterior view of the extirpated tonsil from a case of chronic follicular tonsillitis. Bristles have been introduced into the follicles (Frühwald).

Chronic follicular tonsillitis is characterized by a feeling of fulness and discomfort in the region of the tonsils. Upon inspection the tonsils, although not hypertrophied, are perhaps redder than normal, and many of the crypts are filled with a cheesy exudate (Figs. 82 and 84). The neighboring lymphatics are generally enlarged and tender to the touch.

Treatment.—The cheesy secretions should be removed by syringing with normal salt solution by means of a syringe (Fig. 28, 5). The long nozzle is introduced to the bottom of each crypt one after the other. After the tonsils are cleansed in this manner, a fraction of a drop of Battey's solution (Formula 29) is injected into the bottom of each crypt by means of a hypodermic syringe with a long, fine, malleable silver cannula (Fig. 28, 4) and the crypts slit open with a suitably curved knife or scissors in such a manner that concretions (cholesteatoma) are not easily retained. In some instances the cholesteatoma are not within the crypts, but between the tonsil and the plica triangularis (p. 196). Under such circumstances the plica is best removed by introducing one blade of a curved scissors between the tonsil and the border of the anterior pillar and cutting downward as far as the space between the pillar and tonsil extends. The portion of the plica adhering to the tonsil is then removed with a tonsil punch (Fig. 88). This simple operation, sometimes called "circumcision" of the tonsil, is practically bloodless and painless if the parts are first painted with 10 per cent. cocain in 1 : 1000

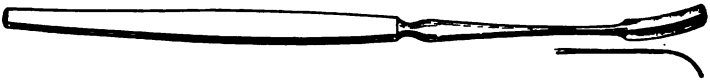

Fig. 85.—Robertson's tonsil knife.

Fig. 86.—Hurd's separator and pillar retractor.

adrenalin solution. It frees the tonsil from its attachments to the anterior pillar and the tongue in such a manner that tonsillar concretions tend to be squeezed from the tonsils by the action of the surrounding muscles during deglutition. In adults it is sometimes as effective in preventing recurrent attacks of peritonsillar abscess as a tonsillectomy; and it is argued that as the name "peritonsillar" implies, the collection of pus is always outside the tonsillar capsule, hence the infection is more likely to have occurred through a mucous follicle at the border of the tonsil as the result of concretions behind the plica than from a diseased crypt within the tonsil. In some cases of the so-called "cicatricial tonsil" vague symptoms of discomfort in the pharynx disappear after removing the plica, probably because freer mobility of the parts is secured.

PERITONSILLAR ABSCESS is sometimes apparently the result of exposure to cold and wet. Recurrent attacks of peritonsillitis often occur in chronic inflammation of the tonsils, with or without hypertrophy. The cheesy secretion that is retained within the crypts or behind the plica triangularis becomes from time to time a source of infection, and inoculates either the tonsillar structure or, more frequently, the surrounding cellular tissue. For these reasons tonsillotomy or partial excision of hypertrophied tonsils is not always followed by a cessation of recurrent attacks of quinsy, because the crypts extend through the tonsil in all cases to the capsule and still continue to harbor cholesteatoma.

Symptoms.—There is a chill or chilly sensations, and pain in the legs and back, headache, and fever which may reach 104° F. As the disease progresses the sufferings of the patient become severe. The dryness of the throat causes frequent attempts at swallowing saliva, which are exceedingly painful. The mouth can be opened only with pain and difficulty and speech becomes almost unintelligible. The tongue is heavily coated and the breath intolerably fetid. The hearing is frequently blunted from extension of the disease to the eustachian tubes, and abscess of the ear sometimes results, while nasal breathing is usually entirely abolished. The fever, pain, and difficulty of swallowing become greater if an abscess is forming, and the relief is proportionate after it has opened. As the patient expectorates the pus he feels almost well, so great is the sense of relief, the fever and pain subsiding together.

Treatment.—A thorough application of a 12 per cent. solution of nitrate of silver frequently aborts the attack if applied early and the inflammation is superficial. The silver solution should be freely painted upon the tonsils and adjacent inflamed mucous membrane by means of a swab of cotton. The relief experienced by the patient is almost instantaneous, and the application should be repeated once or twice a day until all inflammatory symptoms have subsided. It is best to open the patient's bowels thoroughly at the commencement of an attack by means of a saline cathartic. When these measures do not succeed in aborting the attack, but the fever and the suffering of the patient are constantly increasing, aconite in drop doses of the tincture every hour or two until eight to ten doses have been taken will give most excellent results. When pus has formed the abscess should be opened.

The surgeon should carefully search for fluctuation by means of his forefinger introduced into the patient's mouth. As the abscess is almost always peritonsillar, a fluctuating area is most commonly felt through the anterior pillar *above* the tonsil. Into this place, the so-called point of election (Fig. 87), a small bistoury should be carefully thrust with the blade vertical, in order to avoid cutting any large vessel that may occupy an anomalous position in this region. If a sudden secession of resistance indicates that an abscess cavity has been penetrated, the blades of a pair of angular scissors or forceps should be introduced and the puncture stretched open until the pus has escaped. If necessary the opening may be enlarged by cutting downward with a probe-pointed knife. The cavity may then be washed out with sterile water. The escape of pus is followed by immediate and great relief and all symptoms usually quickly subside. Even when no pus escapes from the incision, the bleeding affords a certain amount of relief and may bring about resolution of the inflammation.

Frequently a peritonsillar abscess may be opened with a strabismus hook or a stout steel probe of similar shape. The tip of the instrument is inserted into the supratonsillar fossa as deeply as possible, and an effort made to enter one of the vertical crypts or insert the probe between the tonsil and the anterior pillar. When this is accomplished pus will sometimes well out alongside the instrument. Generally the escape of pus is sufficient to bring about a cure, but in some cases it is necessary to maintain the opening by the daily passage of a probe. Newcomb has collected from medical literature 51 well authenticated cases of severe hemorrhage, with 28 deaths following the spontaneous or operative opening of peritonsillar abscesses, apparently the result of the sudden removal of pressure from an artery involved by the suppuration. While in post tonsillectomy hemorrhages it is usually sufficient to ligate the external carotid below the origin of the ascending pharyngeal and as close to the bifurcation as possible, severe hemorrhage following a suppurative process generally requires ligation of the common carotid.

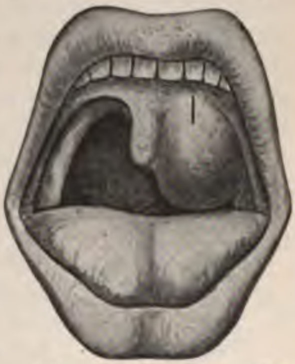

Fig. 87.—Phlegmonous tonsillitis. The black line represents the so-called point of election for puncturing a peritonsillar abscess, but it is not high enough, as the incision is made through the palate and not into the tonsil.

Cyst of the Tonsil.—Occasionally the tonsil becomes the seat of cystic disease. Usually the cyst is small in size, but sometimes it may be of sufficient capacity to contain ½ dram of milky fluid, or the contents of the cyst may be of cheesy consistency.

Treatment.—The anterior wall of the cyst should be excised and its interior painted with saturated tincture of iodin or Battey's solution (Formula 29).

Hypertrophy of the Tonsils.—There are four varieties of chronic hypertrophy of the tonsils: First, the ordinary soft hypertrophy of the tonsils found in children and young adults; second, the so-called ragged tonsil; third, the scirrhous or hard tonsil, characterized by an enormous increase of the connective tissue of the gland and a canaliculization of its blood-vessels; fourth, the submerged or buried tonsil, where the hypertrophied tonsil does not project beyond the faucial pillars.

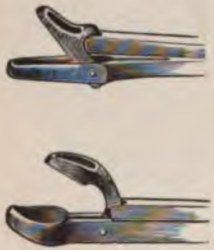

Fig. 88.—Myles' tonsil punches.

Symptoms.—There is generally more or less obstruction to breathing, the patient snoring during sleep. The articulation is thick and there may be some difficulty in swallowing, especially in the cases of young children. The crypts of the tonsil may become filled with cheesy masses, which, undergoing putrefaction, impart to the breath an offensive odor. Hypertrophied tonsils also sometimes interfere with the proper performance of the functions of the eustachian tubes and thus are the cause of aural catarrh and deafness.

Treatment.—Moderate hypertrophy without symptoms requires no treatment; but if the hypertrophy is sufficient to interfere with speech, deglutition, or the functions of the ears, or if there are recurrent attacks of tonsillitis from infected crypts, operation is indicated. Neither adenoids nor tonsils should be removed in infants unless the child is unable to nurse because of nasal obstruction. The teeth, periodontal spaces, and nasal cavities should be examined before accusing the tonsils; and when circumstances permit the operation is best postponed until the child is six years of age.

Tonsillotomy with the tonsillotome is performed as follows: The patient, if a child, should be seated in the lap of an assistant, who holds the child's legs between his own to prevent struggling. The assistant then passes his arms under the child's arms and grasps the child's forehead with his two hands so as to control the movements of the child's head. When the assistant elevates his elbows the child's arms are extended in such a manner as to prevent the child reaching his face with his hands and interfering with the operation.

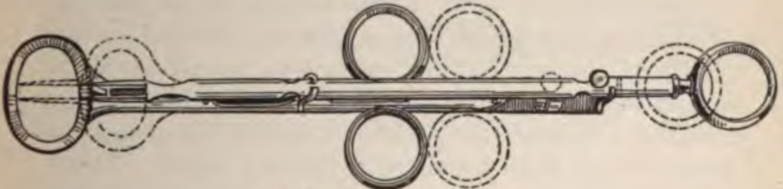

Fig. 89.—Ermold's tonsillotome.

The tonsillotome is introduced into the child's mouth flatwise, like a tongue-depressor, and serves to hold down the root of the tongue and afford a good view of the lower border of the tonsil. The ring of the tonsillotome is now passed around the tonsil from below in order to be sure that the lower border of the tonsil is encircled by the ring, which is pressed firmly against the wall of the pharynx. The blades of the instrument are now closed and tonsillotome and tonsil removed together from the mouth. If the operator is provided with two tonsillotomes it is generally feasible to remove the second tonsil before releasing the child, unless bleeding is so great as to interfere with a view of the fauces.

The operator should be provided with a set of at least three sizes of tonsillotomes, in order that he may select one with a ring of just sufficient size to snugly fit around the tonsil to be removed. After encircling the tonsil the instrument should be closed somewhat deliberately, and the operator should be careful to make no effort to remove the tonsillotome from the mouth until the tonsil has been completely severed. The operation is not especially painful, and probably causes less discomfort to the patient than the administration of ether. However, there is no objection to administering ether for tonsillotomy. Under such circumstances the tonsils are removed with the child lying on its side and its head turned to one side, with the foot of the operating table elevated about 3 inches, as previously described for the removal of adenoids (p. 203).

Tonsillectomy, or the complete removal of the tonsil, in contradistinction to tonsillotomy, or the removal of that portion of the tonsil projecting beyond the pillars of the fauces, is advocated by the larger proportion of laryngologists. Tonsillectomy is always advisable in submerged tonsils and in small tonsils with diseased crypts. Tonsillectomy can be done on docile adults after the injection of local anesthetics into the tissues about the tonsils (Formula 11), but it is better undertaken under etherization. The position of the patient on his side and the elevation of the operating table is the same as for the removal of adenoids.

A mouth-gag is inserted, the tongue is held down and forward with a depressor; mucus and saliva are removed from the pharynx with a gauze sponge; the tonsil is grasped with stout volsellum forceps provided with a catch to render them self-retaining. The upper blade of the instrument should be in the supratonsillar fossa and the lower inserted into the lower border of the tonsil in such a manner that a part of the capsule and so considerable a portion of the tonsil is included within the grasp of the forceps that they will not readily tear out. The tonsil is now pulled toward the median line of the pharynx, so that its extent beneath the anterior pillars is readily seen. While traction toward the median line is maintained, the anterior and posterior pillars are dissected loose from the tonsil by means of the tonsil knife (Fig. 85), the tonsil being rotated downward and inward out of its bed or pushed or pulled away from the pillars to facilitate the procedure. Especial attention is directed to the attachment of the tonsil to the anterior pillar at the point where the plica triangularis leaves the anterior pillar to extend backward over the lower third of the tonsils. The capsule of the tonsil extends forward and medianly to attach itself to the edge of the anterior pillar at this point, and hence, severing this attachment, opens up the space behind the capsule and permits the tonsil to sag outward from its fossa toward the median line of the pharynx. The tonsil is attached now only by its lateral portion to its bed, from which it can be still further enucleated by the use of the finger-tip inserted into the supratonsillar fossa; or with Hurd's enucleator, a stout steel curet, slightly curved at the tip, which is about the size but much thicker than the forefinger-nail (Fig. 86). The loop of a snare (Fig. 90) is now slipped over the forceps and made to surround the base of the tonsil, which by the use of the enucleator and finger-tip has become pedunculated and adherent only at its inferior portion. As soon as the tonsil is enucleated its fossa should be filled with a small gauze sponge, either held in long curved tonsillar hemostats or placed in position and firm pressure maintained with the fingers. After a few moments the wound should be in-

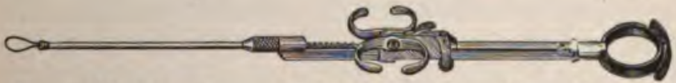

Fig. 90.—Martin's tonsil snare. This is one of the best of the tonsil snares that can be used readily with one hand. Tyding's snare, although larger and more clumsy, removes the tonsil as quickly as a tonsillotome, and hence is certainly the preferable instrument when operating without general anesthesia.

spected. Frequently it will be nearly dry or oozing at only a few points, which can be clamped with tonsillar hemostats or disregarded until the other tonsil has been removed, by which time the wound may have become entirely dry. When the patient is lying on the left side the left or lower tonsil is removed first, then the right or upper tonsil, and finally adenoids if present.

In some cases it is difficult to at once grasp a sufficiently large portion of the tonsil to prevent the forceps tearing out when firm traction is made, especially when some of the tough fibers of the capsule are not within the grasp of the forceps. Under such circumstances it may be desirable to draw the tonsil out of its bed toward the middle line of the pharynx before applying the forceps. Tenaculum forceps of many patterns have been devised by operators: some with four prongs, some with six, and some with even eight. The author's preference is for a small four-pronged instrument bent laterally near the tip; in fact, the familiar double tenaculum forceps used by surgeons during the past half century or more, whether or not it is provided with a catch is a matter of complete indifference, but its small size is a decided advantage over the larger six- or eight-pronged instruments. It is convenient for the operator to be provided with several tenaculum forceps, so that if one shows a tendency to tear loose another can be applied further back through the capsule of the tonsil. The entire operation can be done with forceps and Hurd's enucleator or some similar instrument, or even with forceps and the finger-tips. The objection to this procedure is the unnecessary traumatism and shock occasioned by the rough handling of the parts. It is far preferable to cut the small amount of cellular tissue binding the anterior and posterior pillars to the sides of the tonsils with a sharp knife, thus making a smooth cut through the mucous membrane and preserving as much of it as possible. The hemorrhage is so trifling that the parts are easily in view until the base of the tonsils is reached. Then when Hurd's enucleator is pushed underneath the tonsil it serves to lift the tonsil and prevent the necessity of very hard traction with the forceps. It is sufficiently blunt to prevent much hemorrhage; not more than enough blood to stain a few sponges being usually lost unless the foot of the operating table is raised sufficiently to cause congestion of the pharynx.

The attachment of the lower pole of the tonsil is often thick and tough, and while it can be torn through with the finger or an enucleator, it is better to cut it with scissors or a snare. For this purpose any snare large enough to carry No. 9 piano wire will answer, and the more *quickly* the loop can be closed the better. Before tightening the loop the parts should be inspected to see that the uvula is not included, which might occur if there is considerable oozing of blood. If there is any difficulty in keeping it out of the way it should be grasped by its tip with a small hemostat, which will effectually prevent its being included in the loop.

Open wounds of the pharynx heal more quickly if let alone, especially when retching, gagging, and increased irritation result from medication of the wound. Frequently a superficial slough presents somewhat the appearance of a pseudomembrane, but is without significance as far as healing is concerned. However, cases of sepsis severe enough to endanger life and thrombosis of the internal jugular extending upward into the cavernous sinus have been reported. The patient should remain in bed for a day or so, or until the temperature is normal, and subsist on a soft diet until the soreness of the parts subsides sufficiently to permit the swallowing of more solid food. If the wound is not doing well, it may be touched with a 12 per cent. solution of silver nitrate or dusted by means of a powder-blower with a powder of iodoform, tannic acid, and bismuth (Formula 118), which will closely adhere to the wound and remain in contact with it for a long time.

Some operators prefer to enucleate the tonsil by everting its capsule. The center of the tonsil is seized with small volsellum forceps and gentle traction made at the same time that the tonsil about the forceps is snipped with scissors and its tissues pushed at each side toward the pillars. Under these circumstances the central portion of the tonsil is first pulled out through the orifice of its capsule, very much as if the finger of a fur-lined glove were turned inside out, until finally the entire tonsil including its capsule is in the pharynx external to the pillars to which the rim of the capsule is still attached. The loop of a snare is then passed over the everted tonsil in such a manner as to push back the pillars, and the tonsil removed by tightening the loop. Those that practice this method of operating claim that it produces less traumatism of the surrounding structures and less cicatricial contraction; that by pulling the tonsil through the orifice of its capsule the so-called "buried" or "submerged" tonsil looses its distinctive characteristics and is then as easily removed as an ordinary tonsil. Their theory is that the tonsil is practically a lymphatic gland with its pharyngeal surface devoid of capsule; but that when the orifice of the capsule is not sufficiently large to permit all of the developing tonsil to grow through it, the tonsil remains "buried" or "submerged" in the surrounding tissues.

Accidents and Untoward Results Following Tonsillectomy.—Damage of the posterior pillars which are concerned in the elevation of the larynx may have a detrimental effect on the singing voice, and injury of the anterior pillars resulting in cicatricial contraction may interfere somewhat with the movements of the tongue in deglutition. The sudden great enlargement of the pharyngeal space by the removal of a hypertrophied tonsil often changes the character of the singing voice either for better or worse.

Occasionally operations on the tonsil are followed by dangerous hemorrhage. This generally occurs at the time of the operation or some hours after the patient is thoroughly recovered from the ether. Before operating, the pharynx should be carefully inspected for anomalous arteries and the region of the tonsil palpated to detect any unusual pulsations. Resident physicians in hospitals should be trained in the methods of controlling hemorrhage after tonsil operations, and nurses should be instructed to inspect a child from time to time after a tonsillectomy to be assured that the child is not swallowing blood; for when hemorrhage occurs some hours after the operation in young children the blood is usually swallowed; so that the first symptom of danger may be the vomiting of a large quantity of blood, rapidly followed by collapse. Under such circumstances a tonsil clamp may be useful in controlling the hemorrhage until more effective measures can be instituted. The clamp can be applied either alone or over a gauze sponge inserted into the tonsillar fossa. However, no clamp is as effective in controlling hemorrhage as digital pressure through a gauze sponge on the bleeding tissues. The pressure should be continued for a few moments, the sponge then gently removed, and the parts inspected. It is possible that all parts of the wound will be found apparently oozing blood. Under such circumstances the sponge should be moistened with peroxid of hydrogen, inserted into the tonsillar fossa, and pressure again applied. Upon the removal of this second sponge the hemorrhage will be manifestly less, and probably will be controlled by painting the parts with dilute Monsel's solution. Possibly one or more points will still continue to bleed, and to these the undiluted Monsel's solution should be applied by means of a cotton-tipped applicator held firmly upon the bleeding point. Monsel's solution is an irritant and the undiluted solution should be used with care that no excess of the solution trickles down the pharynx into the larynx. After the oozing of blood from one tonsil is controlled, the other should be treated in the same manner, and if blood is seen flowing from the adenoid wound behind the palate, dilute Monsel's solution should be painted upon this wound also by means of a bent cotton-tipped applicator.

If the removal of a tonsil is followed immediately by profuse hemorrhage, it should be controlled by inserting one or more sponges into the tonsillar fossa and making firm digital pressure. After a few moments the sponges are cautiously withdrawn in such a manner that one part after another of the wound is exposed, so that any spurting artery can be seized by long Kocher hemostats and tied. If at the first attempt the vessel is not seized, a slight twist upon the instrument will probably control the hemorrhage sufficiently to enable the operator to see the bleeding spot more distinctly and clamp it with a second pair of hemostats. Small spurting arteries give no especial trouble except that it is a little more awkward to tie them than in a superficial wound. Occasionally a vessel upon the inner surface of the anterior pillar will bleed in such a manner as to momentarily confuse the operator; because when the pillar is drawn forward the pressure will be sufficient to control the hemorrhage, which recurs immediately the pillar is released. However, if the anterior edge of the pillar is seized with forceps in such a manner that its cut posterior surface can be inspected, the bleeding vessel is easily found and tied.

Hemorrhage after the removal of adenoids may be so severe as to require a postnasal plug of iodoform gauze in order to control it, which is inserted in the manner already described for the control of nasal hemorrhage.

Occasionally after the removal of adenoids and tonsils patients recover from their ether very unsatisfactorily and for a long time remain nearly pulseless with shallow respiration. The extremities are cold and the little patient, although conscious, is aroused with difficulty to answer questions. Such symptoms occur sometimes in children who are fairly robust and who have not received an inordinate amount of ether nor lost a large amount of blood at the operation. Fatal cases of this character have been attributed to the presence of a thymus gland that has not undergone spontaneous metamorphosis and partial absorption, the so-called "habitus lymphaticus." It is probable that in some of the fatal cases reported the element of surgical shock must have played an important rôle; and that it is always safest to subject the tissues of the pharynx to as little rough handling as possible during tonsillectomies and as little blunt dissection as is compatible with safety from hemorrhage. If during the operation the use of the tongue-depressor causes the patient's respiration to cease, pressure should be relaxed until the respirations become normal. If necessary, the tongue should be drawn out of the mouth with volsellum forceps and pressure applied to only that portion of its base necessary to display the tonsil. In some cases embarrassed respiration becomes very much improved after the removal of the first tonsil. No more ether should be used than is necessary to produce relaxation of the pharyngeal muscles, and it should be remembered that the pharyngeal reflex is one of the last to disappear under ether. There should be no more hemorrhage than is unavoidable, and the surgeon or his assistant should take the time and pains to stop practically all bleeding after one tonsil is removed before removing the other. Lowering the head more than is just sufficient to prevent blood gravitating into the larynx or lowering the head by bending the head backward so greatly increases the congestion of the pharynx that what is gained by decreased probability of blood reaching the larynx is lost by increased congestion. Consequently there is commonly less hemorrhage with the patient lying on one side, as already described, so that blood gravitates into the hollow of the cheek, than when the patient is prone, because there is less necessity for greatly lowering the head.

If in spite of precautions the little patient is profoundly shocked by the operation, the foot of the bed should be raised and oxygen administered. The heart's action should be maintained by heat over the heart and strychnin, and blood-pressure increased by the use of 8 ounces of normal salt solution by hypodermoclysis and the institution of enteroclysis by the drop method.

Sepsis severe enough to threaten life, deep cervical cellulitis resulting in abscess, and thrombosis of the internal jugular extending through the lateral sinus into the cavernous with resulting loss of vision in one or both eyes have been reported. Considering the fact that the mouths of children on whom tonsillotomies are done often contain carious teeth, it is astonishing that such wounds do not oftener become infected. However, it is noticeable that infection most often occurs at the hands of those who are most careful of the after-treatment of tonsillectomy wounds, and it is possible that the gagging and retching and consequent irritation of the wound may invite infection rather than tend to prevent it. The author's routine treatment of tonsillectomy wounds consists of inspection for the first three days. His only case of infection occurred in a young woman with a tubercular history who developed a severe cervical adenitis followed by abscess.

Many cases of abscess of the lung following tonsillectomies have been reported. In some instances the condition is pyemia from an embolus originating in one of the veins of the tonsillar fossa. This is probably the explanation in cases developing a week or more after the operation. However, the more frequent cause is the inspiration of blood or bits of tissue, or more probably cheesy concretions of the tonsil at the operation.

In children whose mental dulness and backwardness at school results from recurrent partial deafness aggravated by the presence of hypertrophied adenoids and tonsils, removal of the offending organs often brings about a marvelous improvement in the mental and physical condition of the child; but unless the hearing is affected the mere removal of adenoids and tonsils will not convert a foolish and incorrigible juvenile into a bright, sweet, and lovable child. On the contrary, the results on the nervous system sometimes are directly opposite, and such cases apparently occur most often in instances where the indications for operation were least apparent. In one such case the operation seemed mainly to have been done because other children in the neighborhood had had their adenoids and tonsils removed. In a case reported of an adult who had had but one attack of acute tonsillitis in thirty years, tonsillectomy was followed by a neuritis that confined the patient to bed for many months. He had recovered from an attack of polyneuritis five or six years before, and a mild recurrence suggested the removal of his tonsils as possible sources of infection; but under the microscope the removed tonsils showed no areas that could be interpreted as possible foci of infection.

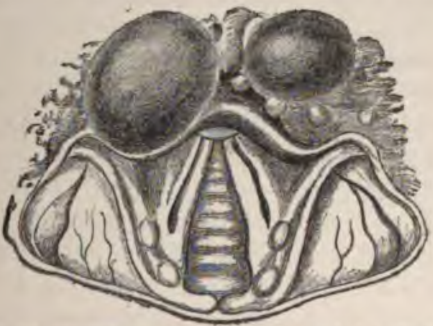

Fig. 91.—Large hypertrophy of the lingual tonsil. More frequently the hypertrophy appears as sessile elevations crowding the space between the base of the tongue and epiglottis (Rice).

The **lingual tonsil** is subject to the same diseases that affect other adenoid structures of the pharynx. Occasionally a venous varix occurs at the base of the tongue on and about the lingual tonsil. If its size is a source of irritation the principal veins should be destroyed with the galvanocautery, which, for this purpose, should not be above a dull-red heat or the vein will be opened and hemorrhage occur. The lingual tonsil (Fig. 91) becomes sufficiently hypertrophied sometimes to cause the sensation of a foreign body and reflex cough. Under such circumstances the redundant tissue should be cut away by suitably curved scissors with serrated edges to prevent the flabby tissue slipping from the blades, by Myles' lingual tonsillotome, or by removing the elevations one after the other with a snare. However, the application of nitrate of silver (20 per cent.) gives relief from reflex cough and in mild cases is curative. Occasionally the so-called lingual goiter is found at the base of the tongue and should not be mistaken for hypertrophied lingual tonsils.

Acute pharyngitis is an acute inflammation of the mucous membrane and underlying structures of the pharynx

Etiology.—Acute pharyngitis is generally the result of exposure to wet and cold, especially of persons of the rheumatic diathesis or of debilitated constitutions. It may also result from traumatism or the presence of a foreign body in the pharynx. Slight unilateral pharyngitis is not uncommon after an intranasal operation, and is probably due to a mild infection. It lasts for a day or two and then passes away.

Pathology.—The inflammation usually is by no means evenly distributed, the glandular elements being always most affected. Their secretion is at first increased, but becomes after a time decreased, starchy, and glue-like in character. The tonsils are always involved to a greater or less extent.

Symptoms.—The constitutional symptoms usually are trifling—a feeling of lassitude with slight fever. The throat feels sore, dry, and stiff. The local symptoms may increase until pain, especially when deglutition is attempted, becomes quite severe. The cervical glands are often swollen and painful to the touch. The voice is usually husky and a sensation as of a foreign body in the throat keeps the patient hawking and spitting. When the tonsils or larynx are seriously involved in the inflammation, symptoms are present referable to these organs.

Treatment.—A saline cathartic should be administered in sufficient quantities to secure one or more free movements of the bowels. A 10 per cent. solution of nitrate of silver should be freely painted over the inflamed lateral walls once or twice a day. It is immediately followed by a sensation of relief and comfort, and tends to materially shorten the course of the disease. Applied to the posterior pharyngeal wall solutions of silver nitrate of over 1 or 2 per cent. produce a sensation of dryness, stiffness, and discomfort, and stronger solutions should not be used. In this region a 10 per cent. solution of argyrol sprayed upon the parts is preferable to the use of the nitrate. When acute pharyngitis is the result of the presence of a foreign body, it should, of course, be at once removed and the inflamed pharynx treated as ordinary acute pharyngitis. When the rheumatic diathesis exists, the administration of guaiac (Formulas 62 and 63) will be found to yield most excellent results, while in gouty sore throat colchicum should be prescribed. A spray of adrenalin chlorid (1 : 10,000) used every hour by the patient quickly relieves the congestion in most cases, but other astringent sprays are sometimes equally efficient; the best probably is alumnol (1 dram to 4 ounces of water). If it is inconvenient for the patient to use an atomizer, lozenges may be prescribed. The camphomenthol lozenge (Formula 66) is sedative and relieves the feeling of dryness and stiffness by increasing the secretions, and the same may be said of a lozenge of guaiac and potassium iodid. However, one of the most popular lozenges in this condition is that of guaiac and tannic acid (Formula 64).

Simple chronic pharyngitis is a chronic inflammation of the mucous membrane of the pharynx, generally the result of chronic rhinitis or accessory sinus disease. The disease is often complicated by inflammation of the follicles of the mucous membrane, and is then called follicular pharyngitis.

Treatment.—It is all important to bring about a cure of the nasal disease, to the presence of which the pharyngeal malady is due. After a cure of the primary nasal affection has been brought about, simple chronic pharyngitis will get well almost without treatment. During the treatment of the nasal affection, however, applications should be made to the vault of the pharynx of Formulas 111, 112, or 113 in the following manner: A tongue-depressor (Fig. 8) should be used to hold down the tongue and the patient requested to try to breathe through his nose or say "One" in order to relax the palatine muscles, when the application may be made without difficulty by means of an applicator, the end of which has been wrapped with cotton and bent to a suitable curve. Should, however, the palate lie closely in contact with the pharyngeal wall, considerable force will be required to carry the end of the applicator into the postnasal space, while most of the solution with which the cotton on the end of the applicator has been saturated will be squeezed out and remain in the fauces. Applications made in such a manner tend rather to increase the existing inflammation than to subdue it, and it is always best to desist from making an application to the pharyngeal vault rather than employ force. When the uvula has become elongated or the mucous membrane of the fauces relaxed as the result of constant *hawking* the daily application of the spray from an atomizer containing a solution of sulphate of copper (2 gr. to 1 ounce of water) will render material assistance in restoring the "relaxed throat" to a condition of health. In some instances it is necessary to amputate redundant mucous membrane at the tip of the uvula.

Chronic follicular pharyngitis, or clergyman's sore throat, is a chronic pharyngitis characterized by inflamed and hypertrophied lymph-follicles.

The *pathology* is similar to simple chronic pharyngitis, except that the lymph-follicles are involved in large numbers and to a greater degree. The subdivision of pharyngitis and follicular pharyngitis is a matter of convenience rather than fact, as in all simple inflammations of the pharynx the mucosa, the lymph-follicles, the submucosa, and often the muscles are usually involved in varying degrees. The watery portions of the secretions are decreased and hence the expectorations are thick and glue-like from an increased proportion of mucin, epithelium débris, and mineral salts.

Etiology.—The disease is generally the result of or part of a nasopharyngeal catarrh, nostrils too wide to efficiently warm and moisten the inspired air, excessive or faulty use of the voice, excessive use of tobacco and distilled liquors, the rheumatic or gouty diathesis, indigestion, and, in women, pelvic diseases.

Symptoms.—The secretions are usually somewhat scanty and viscid, but voided with considerable difficulty. There is a short, frequent cough, distressing alike to patient and friends; the so-called "useless cough," because it accomplishes nothing, either in ridding the throat of secretions or the constant pharyngeal irritation, of which many of these patients complain.

The appearance of the pharynx varies somewhat; usually there is a venous hyperemia over the entire surface, but greatest in the neighborhood of patches of hyperplastic follicles. In other cases the pharynx is less congested, the hypertrophied follicles projecting above the surrounding surface and surrounded by varicosities. Sometimes a number of inflamed follicles coalesce in such a manner as to form a red, sore, and swollen area of considerable size. If such patches be situated close to the posterior pillars, so that they are rubbed and irritated by these folds of mucous membrane with every motion of the pharyngeal muscles, the sufferings of the patient amount to actual pain.

Treatment.—The irritability of the mucous membrane covering areas of hypertrophied follicles can be decreased by lightly painting with a 12 per cent. solution of nitrate of silver. However, care should be exercised to prevent the silver solution spreading over the surrounding mucous surface, because strong solutions of silver nitrate are irritating when applied to the *posterior* wall of the oropharynx.

A certain amount of relief is experienced by the use of demulcent lozenges, either slippery elm, red gum, camphomenthol (Formula 66), or, better still in many instances, a lozenge of orthoform.

Where the so-called useless cough is a prominent symptom, it should be controlled by appropriate doses of sodium bromid. For this purpose as much as 10 to 15 gr. after meals and at bedtime will be required. The matter is of considerable importance, as the constant coughing greatly irritates the pharynx and increases the existing inflammation.

The condition of the tonsils should be carefully examined. Often they are slightly hypertrophied and the crypts contain cholesteatomatous masses. The removal of any concomitant disease of the nasal cavities also will have much to do with the success of the treatment.

The hypertrophied follicles can be destroyed by touching one at a time with Battey's solution (Formula 29).

With many practitioners the radical destruction of the diseased glands by means of the *galvanocautery* is a favorite method of treatment. A very small cautery-knife should be selected, and great care should be exercised not to burn too deeply, or the resulting scar will cause more trouble than the original disease. It is unwise to apply the galvanocautery-knife to more than two or three hypertrophied follicles at one time, or the treatment may be followed by a somewhat sharp attack of acute pharyngitis.

Emil Mayer removes the offending follicles by means of a special curet. By this method of treatment, which is much less painful than the use of the galvanocautery, all the hypertrophied follicles are removed at a single sitting.

Atrophic pharyngitis is an atrophic condition of the mucous membrane and submucous tissue of the pharynx.

Etiology.—Atrophic pharyngitis generally results from the inadequate warming and moistening of inspired air and long contact with the irritating discharges of nasal catarrhs. It frequently exists when atrophic rhinitis is present. A dry condition of the faucial mucous membrane, amounting almost to pharyngitis sicca, is found in all mouth-breathers, but disappears spontaneously as soon as the nose has been rendered sufficiently patulous.

Symptoms.—The patient complains of his throat feeling dry and stiff. Upon inspection the mucous membrane of the throat appears light colored, thin, and as if varnished. Frequently the mucous membrane is so thin that the outline of each cervical vertebra can be distinguished. Sometimes masses of inspissated mucus, perhaps dark colored from the dust inhaled, and swept into ridges by the motions of the soft palate, are seen adhering to the atrophied mucous membrane.

Treatment.—Attention should be mainly directed to the condition of the interior of the nose, because when a cure of the nasal affection has been brought about, the concomitant throat disease will get well almost without treatment. The general health should receive attention, and if necessary tonics should be prescribed, while a sluggish condition of the bowels may indicate the use of saline laxatives. If atrophic rhinitis has caused the affection, plugs of cotton, previously mentioned as useful in atrophic rhinitis, should be made long enough to project somewhat from the posterior nares into the pharynx, while a weak solution of nitrate of silver (gr. v–xv to f℥j) should be applied to the atrophied mucous membrane, both above and below the soft palate, to stimulate the atrophied glands to increased secretion and bring about renewed growth of the atrophied structures. In certain cases it may be advisable to give for a short time some drug like iodid of potassium, phosphorus, or muriate of ammonia to stimulate the pharyngeal secretions. A pill containing $\frac{1}{100}$ gr. of phosphorus may be given after meals or the lozenge of guaiac and iodid of potassium, one every three or four hours, may be ordered. It should be borne in mind that the stomach does not tolerate well any lengthy administration of these remedies, and in most cases their use is best avoided.

Hyperkeratosis or **mycosis of the pharynx** is a disease involving in most cases the faucial, pharyngeal, and lingual tonsils, although other parts of the upper respiratory tract do not always escape. It is characterized by little white, conic elevations, sometimes as large as a grain of rice, due to accumulations of horny epithelium extending outward from crypts and follicles, with an admixture of bacteria and sometimes fungi of the mycosis class, most frequently the Leptothrix buccalis.

Etiology.—Leptothrix is so frequently found in the secretions of the mouth that it might almost be termed a normal constituent. It is especially prevalent in the mouths of individuals with carious teeth, accumulations of tartar, etc. Why it should in some individuals cause the horny, chalk-white growths characteristic of mycosis is not well understood, and it is probable that bacteria play an unimportant rôle in the causation of the disease.

Symptoms.—A few cones of keratosis may be present in the pharynx without causing any symptoms whatever. Under such circumstances the masses may be discovered incidentally upon the tonsils while examining the throat. Usually, however, patients with mycosis complain of a tickling sensation in the pharynx and spasmodic cough.

Treatment.—On the tonsils and other easily accessible portions of the pharynx the little masses should be grasped one by one and pulled off with alligator forceps or, better, Hartmann's ear forceps. After the removal of the little masses the mucous membrane where they grew should be brushed with 10 per cent. nitrate of silver. In inaccessible localities, like the base of the tongue and beneath the epiglottis, hyperkeratosis is better attacked with a small galvanocautery-knife than the forceps

Some of the cones re-form after their removal. Applications of 10 per cent. silver nitrate prevents this to a considerable extent, and occasionally when applied to the surface where hyperkeratosis is will cause the cones to disappear after frequent applications. Ultimately the growths disappear spontaneously if untreated, the disease running its course in one or two years.

Erysipelas of the Pharynx.—Erysipelas of the face sometimes extends to the pharynx, or the disease may originate in the pharynx.

Etiology.—Like erysipelas elsewhere, the disease is the result of the presence of Fehleisen's erysipelas streptococcus.

Pathology.—The fauces are dusky red and swollen. Vesicles form on the surface filled with seropus. The disease is evidently contagious under certain circumstances, as epidemics have been described, notably that in America in 1842. Erysipelas may extend to the middle ear through the eustachian tube or to the lungs through the larynx.

Prognosis.—In the milder cases the prognosis is good. The phlegmonous variety of the disease is almost invariably fatal.

The *treatment* is that of erysipelas elsewhere. Large doses of the tincture of chlorid of iron (20 to 30 drops in water) should be given every three hours, with strychnin, $\frac{1}{30}$ gr., if necessary. The nose and pharynx should be sprayed with an alkaline wash every three hours, followed by adrenalin solution (1 : 1000). The spray of adrenalin should be repeated at intervals of a few moments until the parts have somewhat blanched, after which they should be covered with a 20 per cent. solution of argyrol by means of the spray from an atomizer.

Phlegmonous pharyngitis is an acute infection of the pharynx phlegmonous in character, extending to the deeper structures and usually terminating fatally in from five to ten days.

Etiology.—The disease usually attacks those of broken down constitutions or the aged. There is usually a history of slight traumatism, followed by virulent infection.

Pathology.—There is an enormous swelling of the fauces at an early stage of the disease, followed by a speedy formation of pus, which infiltrates the surrounding tissues and produces pyemia. The organism present in the pus is usually streptococci, or there may be a mixed infection.

Symptoms.—The onset of the disease is sudden. The temperature rises to 103° or 104° F. The throat is sore and, as in a case observed by the author at the Philadelphia Hospital, the swelling may be so rapid as to necessitate tracheotomy within twenty-four hours to prevent suffocation. There are symptoms of general infection; a clammy perspiration, great weakness and debility, often followed by collapse and death.

Treatment.—Local treatment is of little avail. If asphyxia is imminent, tracheotomy should be resorted to; suspected abscesses should be opened either externally through the skin by a free incision or in the pharynx if fluctuation is detected. Hourly hypodermic injections of antistreptococcus serum should be given, with normal salt solution by the rectum. Nutritive enemas also will be necessary if the patient is unable to swallow, with hypodermics of strychnin ($\frac{1}{30}$ gr.) every three or four hours to prevent collapse.

Ludwig's angina was first described by Ludwig in 1836 as a severe infection, beginning in the submaxillary region, where it soon assumes a character which he termed "gangrenous inflammation of the neck."

Etiology is so similar to that of phlegmonous pharyngitis that Semon and others have maintained that the diseases were practically identical. There is usually a mixed infection of streptococcus with staphylococci or diplococci.

Pathology.—The disease is essentially a rapidly spreading cellulitis, beginning in the region of the submaxillary gland from a point of infection, usually a carious tooth, tonsillitis, or an ulcer in the mouth. Fatal results occur from invasion of the larynx, trachea, and the lungs, with general systemic infection. It should be borne in mind that any rapidly spreading cellulitus of the floor of the mouth is a menace to life because the anatomic conditions favor the early involvement of the larynx; and because of the compression of the inflammatory material between the inner sides of the jaw and under the tongue.

Symptoms.—The disease begins as a hard, painful swelling in the submaxillary region, which may run a mild course for days and then suddenly assume an alarming character, because the swelling of the parts interferes with respiration and the swallowing of nourishment. Temperature and pulse are often comparatively low, but dyspnea may require tracheotomy within twenty-four hours of the onset of the disease. In most cases septic intoxication is of less moment as a cause of death than the involvement of the respiratory tract, and death may occur even after tracheotomy in syncope and dyspnea in spite of artificial respiration and oxygen.

Treatment.—Early incision parallel to the lower border of the jaw over the submaxillary triangle should be done in the expectation of laying bare the focus of infection, which is reached with more certainty in most cases than by the safer median incision beneath the chin above the hyoid bone. Incisions on the floor of the mouth are rarely successful in liberating pus. When pus is not found in the submaxillary incision the mylohyoid muscle should be divided and the sublingual cellular tissue exposed. Early incision will probably prevent the irregular septic temperature; profuse sweating and delirium are recorded in some cases. However, after the sublingual tissue has been exposed, should the symptoms indicate, hourly injections of antistreptococcus serum with normal salt solution by the rectum and stimulants should be given, as in the treatment of phlegmonous pharyngitis.

Vincent's angina is an infection of the pharyngeal mucous membrane with fusiform bacilli and spirochetes which are different forms of the same micro-organism. Generally beginning on the tonsils, a pseudomembrane may extend on the surrounding parts. The alveolar process, tooth sockets, bronchial mucous membrane, and even the prepuce may be attacked.

The disease may be associated with diphtheria, syphilis, or streptococcus or staphylococcus infection, and in dental involvement with Bacillus ramosus and the Entamœba buccalis.

Diagnosis.—The disease differs from an ordinary acute pharyngitis due to streptococcus or staphylococcus infection in the usually less severe constitutional symptoms, the great tendency to ulcerations, and the presence of characteristic organisms. However, Vincent states that in the diphtheroid form of the disease there is simply a membranous inflammation without ulceration and that only fusiform bacilli can be isolated.

The *symptoms* are usually those of subacute pharyngitis unless mixed infection is present. Headache, general malaise, with a temperature up to 102.5° F., may be present. The breath is foul, especially when sloughing ulcers are present, the throat painful when swallowing, and there is generally some swelling of the submaxillary glands.

The *prognosis*, where no mixed infection is present, is good, the symptoms abating in three or four days, although some redness of the pharyngeal mucous membrane may persist for many days. In cases of mixed infection the severity of the symptoms depend upon the character of the mixed infection.

Treatment.—When ulcerations are present with sloughing pseudomembrane, the parts should be first thoroughly cleansed, and then 5 per cent. salvarsan in glycerin thoroughly applied, especial attention being directed to the floor of the ulcerations. The ulcers are then covered with an antiseptic powder. Either orthoform or Formula 118 may be used. The spirilla are very sensitive to arsenic, and either salvarsan or neosalvarsan may be injected as in the treatment of syphilis. However, the local treatment is usually sufficient, and as both salvarsan and neosalvarsan are expensive, Fowler's solution of arsenic may be substituted. Daily applications of silver nitrate (12 per cent.) also give good results and may be followed by applications of a 1 per cent. solution of methylene-blue. In mild cases where there are neither ulcerations nor extensive pseudomembranes, applications of 2 to 4 per cent. silver nitrate suffice, the patient in the meantime spraying the throat two or three times a day with ½ to 1 per cent. sulphate of copper.

Syphilitic pharyngitis is an inflammation of the pharynx due to the presence of Treponema (Spirochæta) pallida.

The *primary sore* is not infrequently seen. Mucous patches are by no means rare, while gummata or their characteristic cicatrices are very often met with in the pharynx, especially in dispensary practice.

Symptoms.—In primary syphilis, examination shows a whitish abrasion, soon followed by swelling of the glands about the angle of the jaw. Secondary lesions may present either the form of mucous patches or erythema, characterized by a diffuse redness of the entire fauces or, more commonly, in milder attacks, by a broad red line extending upward upon each of the anterior pillars, and ending abruptly and symmetrically at the root of the uvula. Mucous patches and erythematous patches in the throat are almost always symmetric; that is, both sides of the throat are attacked in corresponding localities by similar lesions, while tertiary lesions do not as frequently present this symmetry. Gummata more frequently involve the tonsils or soft palate than other parts of the throat. A gumma may be absorbed under treatment or, breaking down, result in a rapidly spreading ulceration. When an ulcerating gumma is situated upon the posterior wall of the pharynx, the cervical vertebræ or even the cervical cord itself may finally become involved, and a fatal issue result. In such cases also the utmost care is required to prevent union of the soft palate and uvula to the pharyngeal wall when the ulceration involves the posterior surface of the palate. Where union has taken place, it is difficult at any subsequent period to permanently restore satisfactory communication between the oropharynx and nasopharynx by any operation because of cicatricial contraction after the operation.

Diagnosis.—The primary sore may be mistaken for a hypertrophied tonsil with a superficial ulceration. The secondary stage may be mistaken for cauterizations, especially with silver nitrate, simple or aphthous ulcers, herpes, tuberculous ulcerations, mercurial stomatitis, Vincent's angina, and diphtheria.

Treatment.—In pharyngeal syphilis, as in syphilis elsewhere, constitutional treatment is of primary importance, and the same remedies may be employed internally as already recommended in the treatment of nasal syphilis. Local treatment consists in maintaining perfect cleanliness of the diseased parts and stimulating mucous patches and ulcerations to heal by daily applications of the acid nitrate of mercury diluted with 5 parts of water, and the application, by means of the powder-blower, of a small quantity of Formula 118 or 119.

Leprous Pharyngitis.—According to Hollmann, leprosy of the pharynx begins by the formation of small tubercles, which break down, forming ulcerations which finally penetrate the soft palate, so that in some instances the perforations are so numerous that the palate resembles a sieve. Similar ulcerations occur on the pharyngeal wall and the tonsils. In some cases a small ulcer may assume a gangrenous character, associated with marked systemic toxemia. Under these circumstances treatment consists in the injection here and there into the gangrenous ulceration of a few drops of a 5 per cent. solution of zinc chlorid, which in a day or two causes a slough which, when separated, exposes clean healthy tissue.

The tonsils often are the seat of leprous tubercles and become greatly hypertrophied, with subsequent fibroid changes.

Tuberculosis.—The presence of the tubercle bacilli is sometimes demonstrable by means of the microscope in the secretions of a mild chronic pharyngitis of nurses and attendants in the tuberculous wards of hospitals. Primary tuberculous pharyngitis with marked lesions is rare. Secondary tuberculous pharyngitis in phthisic patients is somewhat common, and is usually observed as ulcerations resembling those of tertiary syphilis.

Infection probably reaches the pharynx through some localized solution of continuity from the secretion of the tuberculous lungs. Tubercles form in the submucosa, which finally break down and ulcerate.

Treatment.—In cases where there are no marked lung lesions and the diagnosis is obscure, the Wassermann reaction test or antisyphilitic remedies should be administered until the surgeon has satisfied himself that the disease is not syphilis. When ulceration has occurred the ulcers should be cleansed with hydrogen peroxid, cocainized, and touched with lactic acid once in two or three days. As these applications are somewhat painful even after cocainization, it is well not to employ a stronger solution than 25 per cent. until the amount of pain and reaction caused by the application has been ascertained, after which the concentrated syrupy acid may be employed if deemed advisable. Rarely is it necessary to employ the curet, and the prognosis as regards healing is favorable.

Lupus vulgaris is a form of inflammation involving the mucous membrane and submucous tissues of the pharynx, generally ending in ulceration due to the presence of the tubercle bacilli.

Etiology.—The disease is said to be more common on the continent of Europe than in America. It occurs in tuberculous families and in those frequently brought in contact with tuberculous patients.

Symptoms.—The general condition of the patient may be that of good health. The disease is insidious and causes little annoyance until the ulcers are sufficiently large to interfere with the functions of the parts. Early in the disease soft reddish nodules about the size of sago grains appear on one or both sides of the pharynx. These finally break down, producing ulcers which may spread to the pillars of the fauces, the palate, or the larynx, one portion of the ulceration healing while another is extending.

Pathology.—Portions of the diseased tissue cureted away show, under the microscope, typic giant cells. However, tubercle bacilli are found only in small numbers and with difficulty.

Diagnosis.—The ulcerative stage may be mistaken for herpes, syphilis, or epithelioma. The short duration of herpes and the more rapid progress of epithelioma should serve to differentiate the disease from lupus. In suspected syphilis the Wassermann reaction or the "therapeutic test" serves to clear up the diagnosis. The tuberculin test gives a positive reaction, causing local hyperemia and some rise of temperature, which subsides in twenty-four hours. The microscope shows typic tubercle giant cells.

Treatment.—The parts should be thoroughly cureted and the solid stick of nitrate of silver applied. Cures have been reported by the use of the *x*-ray.

Glanders, farcy, or **equinia** is a contagious, specific disease with both local and constitutional symptoms, usually contracted from infected horses. It is due to the presence of the Bacillus mallei.

Symptoms and Course.—Pemphigus-like vesicles appear at the point of infection, usually the face. The vesicles ulcerate and the parts sometimes become gangrenous. Metastatic abscesses occur on the face, trunk, and extremities. In milder cases vesicles and abscesses heal in a short time and the patient recovers. In severer cases there is marked prostration, with rapid rise in the temperature, headache, pain on swallowing, dryness of the throat, and enlargement of the submaxillary and cervical glands. Foul-smelling pus flows from the nose and pharynx and a purulent bronchitis is usually present. The severe form of the disease is usually fatal.

Treatment.—Local treatment consists in cleansing the nasal and pharyngeal mucous membranes with diluted hydrogen peroxid and detergent washes and then spraying the nose and pharynx with carbolated albolene. The systemic treatment should be supportive. There is no known specific remedy for the disease.

Actinomycosis is a parasitic, infectious, inoculable disease, first observed in cattle and later in man. It is due to the presence of the leptothrix, streptothrix, or ray fungus. The most frequent and curable form of the disease is when abscesses form about the jaws or fauces. When the parasite has found a nidus in the lungs or digestive tract the disease is fatal.

Etiology.—Actinomycosis is the result of inoculation with the ray fungus, which gains entrance to the mouth, pharynx, or nose from ingesta or inspired air. The disease may originate primarily in either of these cavities and, more rarely, in the larynx or ear.

Pathology.—A slow swelling occurs, usually first at the angle of the jaw, which renders swallowing difficult. Upon inspection, if suppuration has not already occurred, the mass will be found to be firm to the touch and involve one or more of the cervical glands or the tonsils. At the seat of infection a nodule occurs which breaks down and discharges pus containing typic granular masses, which, upon compression, form star-like bodies, yellowish in color, with a center which stains blue with Mallory's stain.

Symptoms.—These are those of granulating, painless abscess with general systemic infection. The laryngologist is usually first consulted by the patient for catarrh and hypertrophied tonsils. One or more crypts of the tonsils may be suppurating and lined with granulations.

Treatment.—The affected tonsil or tonsils should be amputated. Where this cannot be done, the application of the galvanocautery is the best form of treatment. Each nodule or suppurating crypt should be thoroughly destroyed. Abscesses occurring in localities other than the tonsils should be opened, cureted, and cauterized with the solid stick of nitrate of silver. Iodid of potassium in large doses is stated to inhibit the growth of the ray fungus, and Sawyer reports favorably results from the injection into tumors of from 15 to 30 minims of a 1 per cent. solution of the iodid.

Retropharyngeal abscess is an abscess of the posterior pharyngeal wall. It may be hidden above and behind the soft palate and require the rhinoscope to ascertain its outline; it may be situated opposite the larynx, and only be seen in its entirety with the laryngoscope, or it may be situated in such a manner as to be hidden by one of the posterior pillars of the pharynx. However, the most common seat of abscess is the posterior wall of the pharynx opposite the oral cavity on one side or the other of the median line.

Etiology.—Abscess may occur as the result of phlegmonous inflammation of the cellular tissue of the pharynx, scrofula and syphilis being predisposing causes. Traumatism and necrosis of the vertebræ are sometimes causes of the affection.

Symptoms.—There is usually but slight systemic disturbance. Chilly sensations may perhaps be complained of, but local symptoms are usually the first to attract attention. When the abscess is situated high up upon the pharyngeal wall, a sensation as of a foreign body causes almost constant hawking and spitting, while there may be present obstructed nasal respiration with more or less pain and tinnitus. When the abscess is opposite the larynx, dyspnea is a marked symptom, appearing in "spasms" which may endanger the patient's life, while swallowing of liquids or solids is dangerous, owing to their frequent passage into the larynx. In the case of a child eighteen months old seen in consultation by the writer, the mere attempt to introduce a tongue-depressor into the mouth was followed by collapse and apparent death. The child's life was saved only by a rapid tracheotomy with the only available instrument, a penknife. The next day after the operation the cause of the obstructed respiration was discovered to be a retropharyngeal abscess situated low down in the pharynx opposite the larynx. The abscess was opened and the child made a good recovery.

An abscess in the pharyngeal wall opposite the oral cavity presents none of these symptoms unless very large.

Treatment.—Left to itself, a retropharyngeal abscess will discharge either into the throat or at some more remote point, but as soon as the diagnosis is established an incision should be made into the abscess at its lowest part, and if required the opening maintained patulous by the daily passage of a probe as long as necessary to bring about a cure of the affection.

The author has several times opened a retropharyngeal abscess without general anesthesia with the child in an upright position. However, it is probably better to place the patient on his side, with the foot of the operating table elevated as for a tonsillectomy. The abscess is then located with the forefinger-tip, which serves as a guide for a long-handled knife, and the abscess incised, washed out with boric acid solution, and iodoform emulsion in glycerin injected. When the abscess is complicated by caries of the vertebra it is better opened through the skin by the external route. An incision 2 or 3 inches long is made on a plane with the abscess parallel to the anterior border of the sternocleidomastoid muscles. The deep cervical fascia is opened and the anterior border of the sternocleidomastoid muscle exposed and drawn forward. By blunt dissection the carotid sheath with its vessels and nerves is separated from the vertebra and drawn forward and the dissection carried in front of the vertebra to the abscess wall, which is punctured and a closed hemostat inserted and withdrawn opened. The cavity is then explored by the finger for necrosed bone and a drainage-tube inserted. Aneurysm has been mistaken for retropharyngeal abscess with fatal results following incision, so that it is important to arrive at a correct diagnosis before operating.

Prognosis is favorable except in those cases where the spinal vertebræ are involved. In all operations upon the posterior wall of the pharynx it should be borne in mind that a large artery is occasionally found in this position, probably the vertebral, which sometimes enters its osseofibrous canal as high up as the fourth or even second vertebra. It has been seen to leave its canal at the third vertebra, to re-enter it at the atlas.

Tumors.—Any of the varieties of tumor found in other parts of the body may occur in the pharynx. They are most frequently located in the lateral walls and may involve the surrounding structures. In the following order of frequency there are found in the pharynx gumma, sarcoma, carcinoma, lupus, papilloma, cyst, fibroma, osteoma, enchondroma, adenoma, and aneurysm.

Symptoms.—When the growth is large it may become an obstruction to deglutition or even respiration. In carcinoma and ulcerating lupus pain is present, which in many instances radiates into the ear.

Treatment.—Except in the case of gumma, the treatment of which has been already described, early extirpation with the knife, galvanocautery, or snare should be practised.

NEUROSES OF THE PHARYNX

The more common neuroses of the pharynx are anesthesia, hyperesthesia, paresthesia, neuralgia, and paralysis, either unilateral or complete.

Anesthesia is most often the result of hysteria. The pharyngeal reflexes are abolished; there is a more or less complete loss of pharyngeal sensation when the parts are touched with a cotton-tipped probe. The condition is observed in cases of progressive bulbar paralysis and in the general paralysis of the insane.

The *treatment* depends on the cause of the condition: in hysteria the strong galvanic or induced current with strychnin internally, possibly in increasing doses.

Hyperesthesia is generally the result of some disease of the nose and nasopharynx that has rendered the secretions viscid and sticky, so that frequent hawking is necessary to dislodge them. The excessive use of tobacco, especially chewing tobacco, will produce the condition. In some cases of hyperesthesia of the pharynx the reflexes are increased to such an extent that barely touching the pharynx is sufficient to produce emesis. There is, of course, hyperesthesia of the pharynx in practically every case of pharyngitis.

Treatment.—Cessation of the excessive use of tobacco or cure of the nasopharyngeal catarrh that has produced the condition is ordinarily sufficient to reduce the hyperesthesia to normal and diminish the reflexes. Temporary relief is afforded by the administration of sodium bromid in doses of 10 or 15 gr. three times a day. When the reflexes are not increased to an extent to produce vomiting whenever the pharynx is sprayed, the patient should spray his pharynx three or four times a day with an atomizer containing a ½ to 1 per cent. solution of sulphate of copper.

Paresthesia is most frequently manifested as a sensation as of a small foreign body in the pharynx. This sensation and burning, itching, or tickling, as well as spasm of the pharyngeal muscles, the well-known "globus hysteriæ," are not uncommon in hysteric females. However, in the larger proportion of these so-called hysteric cases some lesion will be found to account for the symptoms if the pharynx be carefully inspected. The most common lesions are inflamed follicles or an erosion on the side of the pharynx posterior to the posterior pillar, or in any other position where two folds of mucous membrane rub together in deglutition.

Treatment.—The symptoms are usually quickly relieved by 10 or 15 gr. of bromid of sodium after meals and at bedtime. After relief has been secured by the use of the bromid, a general tonic treatment should be prescribed for building up the nervous system—rest, iron, quinin, phosphorus. Pil. sumbul comp., one or two after each meal, frequently yields very satisfactory results. When inflamed follicles or any erosion is found in a position where it is irritated by each movement of the pharyngeal muscles, it should be touched every day or two with a 12 per cent. solution of nitrate of silver.

Paralysis of the Pharynx.—*Etiology.*—Paralysis of the pharynx may result from diphtheria or syphilis, or be the result of a cerebral affection involving the nerves that supply the pharyngeal muscles. Transient paralysis of the palate, either unilateral or bilateral, is common as the result of diphtheria; more rarely are the pharyngeal muscles also paralyzed in severe cases.

Pathology.—One or both sides of the pharynx may be involved, and one or all three of the pharyngeal constrictors be paralyzed, as well as the velum palati; but paralysis of the soft palate, either unilateral or bilateral, occurs independently as a "reflex" in ethmoiditis.

Symptoms.—Difficult deglutition; liquids being more easily swallowed than solids, but more frequently passing into the larynx; or, when the soft palate is also paralyzed, both solids and fluids may be forced into the posterior nares through the efforts of the tongue to assist deglutition.

Treatment.—The central cause of the affection should be carefully sought and treated. In suitable cases strychnin, in gradually increasing doses until the limit of toleration has been reached, will do good; while arsenic and tonics are especially valuable where the paralysis is of diphtheric origin.

Foreign bodies of two classes are found in the pharynx: First, those whose bulk does not allow them to pass through the esophagus, and second, sharp-pointed objects, like pins, needles, fish-bones, etc., that are forced into the pharyngeal walls by contraction of the constrictor muscles.

Symptoms.—Large objects may cause death by holding down the epiglottis. Sharp-pointed objects cause a pricking sensation, sometimes felt at two places in the pharynx, as in the case of a pin or needle. Localized spots of inflammation, when situated low down upon the pharyngeal wall, give rise to the sensation of a foreign body, and this fact, as well as the imaginary foreign body of hysteric women, should be remembered after an unsuccessful search for a foreign substance in the pharynx.

Treatment.—It is not always possible to use the laryngoscope to advantage when the foreign body is situated low down in the pharynx, and in such cases the finger should be introduced into the pharynx, and if a foreign body be felt an effort should be made to scratch it loose with the finger-nail and withdraw it. When the offending substance can be seen, a pair of forceps, either straight or curved, according to its position, should be used to withdraw it. It should be remembered that after the removal of a foreign body sometimes a sensation as of its presence remains for some days.

DISEASES OF THE UVULA

Inflammation of the uvula may occur primarily or as the result of extension of inflammation from the tonsils or palate. Occasionally it becomes edematous. The distention may be so great as to produce dyspnea. The treatment consists in cocainizing the uvula, seizing it with a pair of mouse-tooth forceps, and freely incising the mucous membrane in a number of places in order to allow the fluid to escape. The same object may be accomplished sometimes more conveniently by snipping off the mucous membrane at the tip of the uvula.

Pseudomembranous Uvulitis.—The extension of a pseudomembrane from the tonsils to the uvula is somewhat characteristic of diphtheria. However, this occurs in other forms of pseudomembranous pharyngitis.

Treatment of Inflammation of the Uvula.—As inflammation of the uvula generally is only part of an inflammation involving the rest of the fauces, it is best to begin treatment by spraying the fauces with a 1 : 1000 solution of adrenalin; the uvula should then be painted with a 10 per cent. solution of nitrate of silver. This should be done in the physician's office once or twice a day, the patient in the intervals either spraying his fauces every two or three hours with a 1 : 10,000 solution of adrenalin or a 3 per cent. solution of alumnol.

Ulceration of the Uvula.—The uvula sometimes becomes ulcerated as the result of traumatism and infection. Syphilis, lupus, or tuberculosis may be primarily located in the uvula. The uvula is sometimes destroyed by an ulcerating gumma. Occasionally these cases are first seen by the laryngologist when the ulcer has made considerable progress and the uvula hangs, as it were, by a string of mucous membrane. Under these circumstances the uvula sometimes can be saved by the daily subcutaneous injection of bichlorid of mercury, which, although painful, probably yields quicker results than other methods of treatment. Where an ulcerating gumma involves the posterior wall of the pharynx as well as the uvula and soft palate, there is great danger of cicatricial adhesions occurring that may entirely shut off communication between the posterior naris and oropharynx.

Deformities of the Uvula.—*Bifid Uvula.*—The uvula when present is always bifid in cleft palate as the result of the same cause that produces the palate deformity. Hence ordinary bifid uvula might be considered as an incomplete cleft palate. The deformity varies from a little dent at the free extremity of the uvula, which is usually club shaped, to a complete division separating the uvula into two lateral halves.

Treatment.—Bifid uvula, when it causes no symptoms, is best let alone. However, the parts may be freshened by means of a V-shaped incision and sewed together. If the uvula is thoroughly cocainized and then sprayed with adrenalin, the operation is both painless and bloodless. For anesthetizing the uvula simply painting the parts with a 10 per cent. solution of cocain is not sufficient. The operator should be provided with a small cup at the end of a long handle. This is partly filled with a 4 per cent. solution of cocain and held under the palate in such a manner that the uvula soaks in the cocain solution for a few moments before the operation.

Elongation of the Uvula.—The whole mass of the uvula may be hypertrophied. More frequently, however, merely the mucous membrane is relaxed and hangs as a conic tip below the uvula proper. In rare cases a warty growth is attached to the end of the elongated uvula.

Etiology.—It is generally the result of chronic pharyngitis, the constant hawking to dislodge masses of mucus from the pharynx having a tendency to cause the affection. Paralysis of the palate is a reflex sometimes observed in ethmoiditis, and in such cases paralysis of the azygos uvulæ muscles and consequent elongation of the uvula are concomitant with the affection.

Symptoms.—Patients complain of a "tickling in their throats." The elongated uvula hanging in contact with the base of the tongue causes an almost constant short cough as an effort to dislodge a supposed foreign substance. These efforts are sometimes persisted in until nausea and vomiting result. Snoring is usually marked and the sleep is disturbed by dreams.

Treatment.—The redundant portion of the uvula should be amputated. This is ordinarily only relaxed and redundant mucous membrane at the tip of the uvula. It is rarely or never necessary to remove any of the muscular structure of the organ, and amputation of the entire uvula close up to the soft palate is done only for the removal of malignant disease or as the result of the ignorance or awkwardness of the operator. The operation is perhaps best done in the following manner: The uvula is grasped at a point just below where it is decided to amputate with a pair of long hemostats, which are then clamped. The position of the hemostat marks the spot on the uvula where it has been decided to amputate, so that there is no danger of cutting off too much or too little. The uvula is stretched well forward and cut off close to the forceps by a single cut of a pair of somewhat heavy scissors, curved upon the flat, and held with their concavity upward in such a manner that the uvula is cut somewhat obliquely upward; and the wound, being upon the posterior surface, is protected from contact with food during the healing process. Generally there is but little inflammatory reaction and the wound heals promptly, but occasionally a mild acute pharyngitis occurs as the result of the operation when the uvula is thick and fleshy.

THE LARYNX

ANATOMY OF THE LARYNX

THE larynx is an expansion of the upper portion of the trachea, so that there is formed a musculocartilaginous membranous box constituting the essential organ of voice. It lies in front of the pharynx, of which it, with the base of the tongue, forms the lower anterior wall. Its superior aperture slopes downward and backward toward the pharynx and is partly closed from before backward during deglutition by a leaf-shaped lid, the *epiglottis.* The larynx is connected by ligaments and muscles with the surrounding tissues, the muscles serving to draw it upward during vocalization and deglutition.

Cartilages.—The cartilages of the larynx are nine in number, three single and three in pairs: The thyroid, cricoid, and epiglottic cartilages, the arytenoid cartilages, the cartilages of Wrisberg, and those of Santorini. The shapes of these, their relative size, and their manner of articulation and relative position to the hyoid bone are shown in Figs. 92 and 93.

The *thyroid cartilage,* so called from its resemblance in shape to a shield, is composed of two plates or wings, united in front at an angle in such a manner as to project forward beneath the skin of the throat as an elevation—the "Adam's apple." To its outer surface are attached the sternothyroid, thyrohyoid, and inferior constrictor muscles. To its inner surface are attached the epiglottis, the thyro-arytenoid, thyro-epiglottidean muscles, and the true and false vocal cords. The superior borders of the cartilage curves backward from a median notch to the superior cornua or horns. To this border is attached the thyrohyoid membrane or ligament (Figs. 92, 93). The lower border gives attachment to the cricothyroid membrane or ligament in the median line, and on each side to the cricothyroid muscles (Fig. 95). The posterior borders and superior and inferior horns give attachment to the stylo- and palatopharyngeal muscles. To the apices of the superior cornua is attached the thyrohyoid ligament. The inferior cornua articulate with the cricoid cartilage.

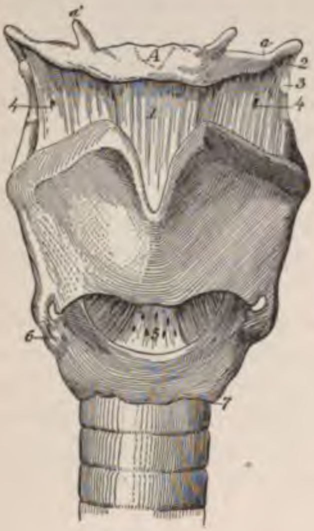

Fig. 92.

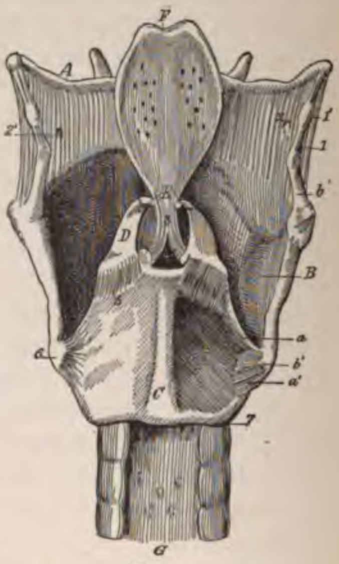

Fig. 93.

Fig. 92.—Articulations and ligaments of the larynx, anterior view: *A*, Hyoid bone, with *a* its greater, and *a'* its lesser cornua; *1–5*, ligaments; *6*, lateral cricothyroid articulation; *7*, junction of cricoid and trachea (Testut).

Fig. 93.—Articulations and ligaments of the larynx, posterior view: *A*, Hyoid; *B*, thyroid, with *b* and *b'* its cornua; *C*, cricoid; *D*, arytenoids; *E*, cartilages of Santorini; *F*, epiglottis; *G*, trachea; *1–6*, ligaments; *2*, opening for superior laryngeal artery; *7*, junction of trachea and cricoid (Testut).

The *cricoid cartilage*, so called from its seal-ring shape, lies below the thyroid with its seal or broad surface posteriorly; laterally it articulates with the inferior cornua of the thyroid by means of small articular facets, and on the superior border posteriorly are two other facets for articulation with the arytenoid cartilages. To its lateral surfaces are attached the crico-arytenoideus posticus muscles and the longitudinal fibers of the esophagus (Figs. 94, 95). To its upper border are attached the cricothyroid membrane and the crico-arytenoidei lateralis muscles; to its lower border a fibrous membrane connecting it with the upper ring of the trachea.

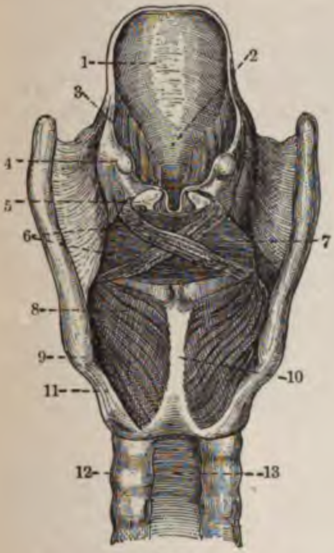

Fig. 94.

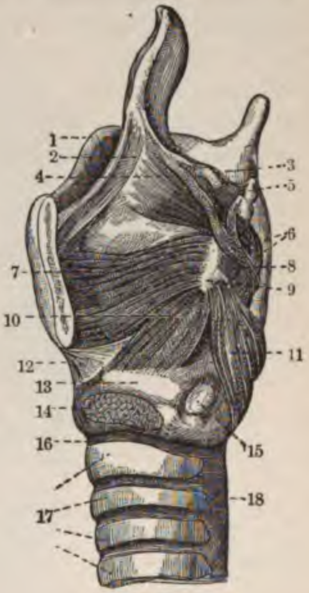

Fig. 95.

Fig. 94.—Larynx with its muscles, posterior view: *1*, Epiglottis; *2*, cushion; *3*, aryepiglottic ligament; *4*, cartilage of Wrisberg; *5*, cartilage of Santorini; *6*, oblique arytenoid muscles; *7*, transverse arytenoid muscle; *8*, posterior crico-arytenoid muscle; *9*, inferior cornu of thyroid cartilage; *10*, cricoid cartilage; *11*, posterior inferior cerato-cricoid ligament; *12*, cartilaginous portion; *13*, membranous portion of trachea (Stoerk).

Fig. 95.—Larynx and its lateral muscles after removal of the left palate of the thyroid cartilage: *1*, Thyroid cartilage; *2*, thyro-epiglottic muscle; *3*, cartilage of Wrisberg; *4*, aryepiglottic muscle; *5*, cartilage of Santorini; *6*, oblique arytenoid muscles; *7*, thyro-arytenoid muscle; *8*, transverse arytenoid muscle; *9*, processus muscularis of arytenoid cartilages; *10*, lateral crico-arytenoid muscle; *11*, posterior crico-arytenoid muscle; *12*, cricothyroid membrane; *13*, cricoid cartilage; *14*, attachment of cricothyroid muscle; *15*, articular surface for the inferior cornua of the thyroid cartilage; *16*, cricotracheal ligament; *17*, cartilages of trachea; *18*, membranous part of trachea (Stoerk).

The *arytenoid*, or "pitcher-shaped" cartilages, articulate with the upper posterior border of the cricoid (Figs. 92–95). To the anterior surface are attached the false vocal cords and thyro-arytenoideus muscles; at the anterior angle or *vocal process* are attached the true vocal cords and the thyro-arytenoideus muscles. To the posterior surface is attached the arytenoideus muscle. To the posterior angle, or processus muscularis (Fig. 97), are attached the crico-arytenoideus lateralis and posticus muscles (Figs. 94, 95). The median surfaces of the arytenoid cartilages are covered with mucous membrane and face each other; their apices articulate with the cartilages of Santorini.

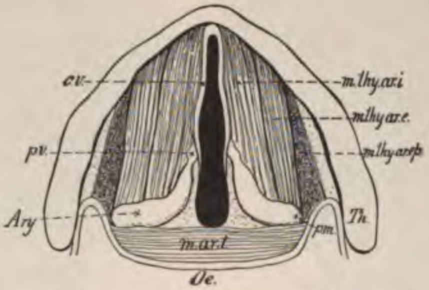

Fig. 96.—Diagram to illustrate the thyro-arytenoid muscles; the figure represents a transverse section of the larynx through the bases of the arytenoid cartilages: *Ary*, Arytenoid cartilage; *p.m*, processus muscularis; *p.v*, processus vocalis; *Th*, thyroid cartilage; *c.v*, vocal cords; *Oe* is placed in the esophagus; *m.thy.ar.i*, internal thyro-arytenoid muscle; *m.thy.ar.e*, external thyro-arytenoid muscle; *m.thy.ar.ep*, part of the thyro-aryepiglottic muscle, cut more or less transversely; *m.ar.t*, transverse arytenoid muscle. (Redrawn from Foster.)

Cartilages of Santorini are two small cartilages at the apices of the arytenoid cartilages, to which are attached the aryteno-epiglottidean folds.

Cartilages of Wrisberg are two little masses of cartilage contained in the aryteno-epiglottic folds.

Epiglottis.—The cartilage of the epiglottis is leaf shaped and attached by its apex to the thyroid's inner surface just below the median notch by the thyro-epiglottidean ligament (Figs. 92, 93). The epiglottic cartilage is covered by mucous membrane. Its base is free and points backward from the root of the tongue, to which its anterior surface is attached by three glosso-epiglottic folds of mucous membrane, and to the hyoid bone by the hyo-epiglottic ligament. The lateral margins are connected with the arytenoid cartilages by the aryteno-epiglottic folds. Its posterior surface covers the superior aperture of the larynx when food passes down the pharynx.

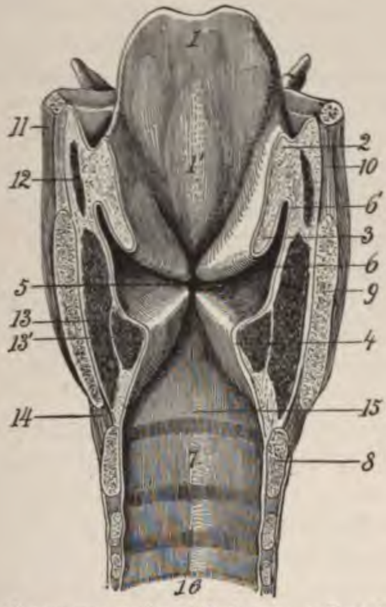

Fig. 97.—Vertical transverse section of the larynx: *1*, Posterior face of epiglottis, with *1'*, its cushion; *2*, aryteno-epiglottic fold; *3*, ventricular band, or false vocal cord; *4*, true vocal cord; *5*, central fossa of Merkel; *6*, ventricle of larynx, with *6'* its ascending pouch; *7*, anterior portion of cricoid; *8*, section of cricoid; *9*, thyroid cut surface; *10*, thyrohyoid membrane; *11*, thyrohyoid muscle; *12*, aryteno-epiglottic muscle; *13*, thyro-arytenoid muscle, with *13'*, its inner division, contained in the vocal cord; *14*, cricothyroid muscle; *15*, subglottic portion of larynx; *16*, cavity of the trachea (after Testut).

Ligaments.—The larynx has nineteen ligaments—three extrinsic, binding the larynx to the hyoid bone, and sixteen intrinsic, binding its various cartilages together.

The *extrinsic ligaments* are the thyrohyoid membrane and two lateral ligaments (Figs. 92, 93).

The *intrinsic ligaments* are the cricothyroid membrane, the cricothyroid capsular ligaments (two), crico-arytenoid ligaments (two), crico-arytenoid capsular ligaments (two). In the false cords or ventricular bands the superior thyro-arytenoid ligaments (two). In the true vocal cords the inferior thyro-arytenoid ligaments (two), the hyo-epiglottic ligament, the thyro-epiglottic ligament, and the three glosso-epiglottic folds.

Muscles.—There are four pairs of lateral muscles and one central muscle, the *arytenoideus*, which extends from the posterior surface and outer border of one arytenoid cartilage to the corresponding parts of the other. There are both oblique and transverse fibers, and the action of the muscle is to draw the arytenoids together and close the posterior portions of the chink of the glottis (Fig. 94). It is supplied by both the superior and recurrent laryngeal nerves.

The four pairs of *lateral muscles* are:

The crico-arytenoideus lateralis, extending from the posterior angle of the base of the arytenoid to the upper lateral border of the cricoid cartilage. This muscle rotates the arytenoid inward and, with its fellow of the opposite side, closes the glottis except for the posterior portion, closed as described above by the action of the arytenoideus, bringing the bases of the arytenoid cartilages together. The lateral crico-arytenoideus is supplied by the recurrent laryngeal nerve.

The cricothyroid, extending from the front and side of the cricoid cartilage to the lower and inner border of the thyroid (Fig. 96). The action of this muscle is to tilt the thyroid forward upon the cricoid and thus stretch and render tense the vocal cords. It is supplied by the superior laryngeal nerve.

The crico-arytenoideus posticus extends from the posterior angle of the base of the arytenoids to the posterior portion of the cricoid (Figs. 94, 95). Its action is to rotate the arytenoids outward and open the glottis while keeping the cords tense. It is supplied by the recurrent laryngeal nerve.

The thyro-arytenoideus extends from the angle of the thyroid cartilage and the posterior surface of the crico-thyroid membrane into the base and anterior surface of the arytenoid (Fig. 97). Its action is to shorten and relax the vocal cords bringing the thyroid and arytenoids closer together and to compress the sacculus laryngis. It is supplied by the recurrent laryngeal nerve.

The action of the intrinsic muscles may be studied by reference to Fig. 96 and the other figures illustrating the anatomy of the muscles of the larynx. Briefly, the chink of the glottis is closed by the action of the arytenoideus and the crico-arytenoideus lateralis. The cords are tightened and made tense by the action of the cricothyroid. The cords are relaxed by the action of the crico-arytenoideus and separated by the action of the crico-arytenoideus posticus. The study of the action of the muscles of the larynx may also be facilitated by inspecting the figures illustrating laryngeal paralysis (Figs. 110–117).

The *muscles of the epiglottis* are three double muscles, all supplied by the recurrent laryngeal nerves. Their action is to depress the epiglottis and compress the sacculus laryngis. The epiglottic muscles are the thyro-epiglottideus, between the inner surface of the thyroid and the epiglottis and aryteno-epiglottic folds; the aryteno-epiglottideus superior, between the apices of the arytenoids to the aryteno-epiglottidean fold; and the aryteno-epiglottideus inferior, from the arytenoid cartilage just above the ventricular bands to the sacculus laryngis.

The **vocal cords,** sometimes called the *true* vocal cords, in contradistinction to the *false* vocal cords or ventricular bands, extend anteroposteriorly across the larynx from the angle of the thyroid cartilage to the anterior angle of the arytenoids (Figs. 93–96). They each consist of a fold of mucous membrane containing the inferior thyro-arytenoideus ligament with the thyro-arytenoideus muscle parallel to it (Fig. 97).

The **ventricular bands** are two folds of mucous membrane containing the superior thyro-arytenoid ligament extending across the larynx above the ventricles of the larynx (Fig. 97).

The **glottis,** or **rima glottidis,** sometimes called the chink of the glottis, is the space between the vocal cords. When the cords are separated during forced inspiration it is triangular in shape, with the apex of the triangle anterior. Its length rarely is 1 inch in the male, and its width posteriorly during inspiration does not exceed ½ inch.

The **ventricles** of the larynx are oval depressions between the ventricular bands and the cords leading upward toward the sacculus laryngis.

The **sacculus laryngis** is the upper portion of the ventricle of the larynx. It contains sixty or seventy small mucous glands, whose secretion lubricates the cords. It is of conic shape and is covered by the aryepiglottideus inferior muscle medianly and the thyro-epiglottic muscle laterally. Both muscles by their action compress it and expel its contents (Fig. 97).

The **mucous membrane** of the larynx is somewhat thin. It is covered with ciliated columnar epithelium below the level of the ventricular bands, extending up in front as high as the center of the epiglottis. Over the rest of the mucous membrane of the larynx is stratified squamous epithelium.

The abrupt change in the character of the epithelium of the larynx probably accounts for the rarity of infection of the pharynx extending into the lower air-passages, as it is a well-established fact that infections of mucous membranes generally respect anatomic boundaries when the character of the epithelial covering suddenly changes.

The **arteries** of the larynx are the laryngeal branches of the superior and inferior thyroid. The most important of these from an operative standpoint is the cricothyroid, which extends transversely across the cricothyroid membrane to anastomose with its fellow of the opposite side. This artery is seldom large enough to require ligation in deliberate operating. However, in emergency cases, where it is necessary to open the cricothyroid membrane as quickly as possible, it is better to cut the cricothyroid membrane transversely in order to avoid wounding this vessel.

The **veins** empty into the superior, middle, and inferior thyroid veins. Ordinarily these are vessels of small size, but in obstructed respiration from stenosis their size is greatly increased.

The **nerves** of the larynx are the superior and recurrent branches of the pneumogastric joined by branches of the spinal accessory and the sympathetic. The superior laryngeal is mainly a nerve of sensation. It enters the larynx through an opening in the thyrohyoid membrane and supplies the mucous membrane, the cricothyroid, and arytenoideus muscles.

The recurrent laryngeal is a motor nerve. It winds from before backward around the subclavian artery on the right side and around the arch of the aorta on the left side, and supplies all the laryngeal muscles *except* the *cricothyroid*. In its course it gives off cardiac, esophageal, tracheal, and pharyngeal filaments. It anastomoses with the superior laryngeal.

Aneurysm of the aorta or subclavian pressing on the recurrent laryngeal nerve produces characteristic paralysis of the laryngeal muscles, and the same is true of hypertrophied or tubercular lymphatics in the mediastinum or in the neck.

The **size of the larynx** varies greatly, being much larger in males than in females and children. At the age of puberty in boys the voice undergoes a rapid change in character and pitch. During this period of change the mucous membrane of the larynx is usually at least somewhat congested, and occasionally individuals are unable to control the pitch of their voices to the extent that they will begin a sentence in a high-pitched voice and end it in a bass voice or the reverse.

Musical notes used in singing have a range of about $3\frac{1}{4}$ octaves, and voices are classified according to their position in the musical scale into soprano, mezzosoprano, contralto, tenor, baritone, and bass. Soprano, mezzosoprano, and contralto voices are usually found in women, while the male voice is usually either tenor, baritone, or bass. *Voice production* is the result of the vibration of the vocal cords amplified by the resonant cavities above; that is, the pharynx, the mouth, the nose; in the same manner that the sound of a tuning-fork is amplified and made many times louder by approaching the vibrating fork toward the opening in a wide-mouthed bottle of a sufficient depth to contain a column of air capable of vibration in unison with the fork. The sound produced by the vibrations of the vocal cords is feeble and practically inaudible until it is amplified and made loud by the vibration of the air in the mouth, pharynx, and nose. The size of this cavity can be greatly reduced by the contraction of the palate, shutting off the cavity of the nose and nasopharynx from the space below, and the size and shape of the cavity of the mouth and oropharynx can be changed by the action of the muscles of the tongue and pharynx; so that it is possible to produce a space containing a volume of air capable of vibrating in unison with and amplifying a sound of any pitch produced by the vibration of the vocal cords. The larynx possesses the characteristics of both reed and string musical instruments. The *pitch* of a sound produced by the vibration of the vocal cords depends upon their length, thickness, and tension. What is called the *falsetto voice* is the result of the cords vibrating not as a whole, but in two or more segments. The resulting sound is high pitched, far above the natural range of the individual's voice, and possessing a timbre or character usually disagreeable. Voices differ greatly in *range*, that is, some individuals have no more than a few notes of the musical scale, while others have 2 and even 2¼ octaves at their command, and above the natural range of their voices a falsetto voice, also of considerable range.

Musical notes have three qualities—*loudness*, *pitch*, and *timbre* or character. We have already learned how loudness of voice is the result of the amplification of the sound produced by the resonant cavities of the mouth, pharynx, and nose. The loudness also is dependent on the force and amplitude of the vibrations of the vocal cords.

The *timbre* or character of the voice is as varied as the dispositions of individuals. It is that quality by which we recognize the voice of an individual as different from all other individuals. In singers the timbre of the voice may be sweet and pleasant or rough, coarse, and unpleasant. It may be nasal, from the presence of adenoids or other growths that render the use of the nose as a resonant cavity impossible. Timbre of the voice is probably the result of the relative size and shape of the resonant cavities, the position of the teeth and lips, and the thousand and one anatomic peculiarities of an individual's vocal organs. In this connection it is well enough to insert a word of caution as to the impropriety of suddenly greatly altering the size or shape of the upper respiratory tract, as, for example, by the ablation of very greatly hypertrophied tonsils in the case of professional singers, for fear that the character of their voice may be changed for the worse rather than the better.

The *singing voice* differs from the speaking voice mainly that in singing the tone is sustained at the same pitch for an appreciable length of time, while in speaking the voice is continually sliding up and down the musical scale on the vowel sounds. (See Acoustics, p. 337.)

DISEASES OF THE LARYNX

Anemia.—The presence of laryngeal anemia is of especial importance: (1) When associated with functional aphonia. (2) When, during the course of an attack of chronic laryngitis, the mucous membrane covering the aryepiglottic folds, arytenoid cartilages, and ventricular bands is abnormally pale while the vocal cords are the seat of indolent congestion, the patient not being generally anemic. Each of the above conditions is premonitory of laryngeal phthisis.

Hyperemia of the larynx is a congestion of the mucous membrane of the larynx, most marked where the submucosa is loose, fat, and thick, as upon the aryepiglottic folds, ventricular bands, and ventricles; the epiglottis, vocal cords, and inferior cavity of the larynx being but little altered in color. Its presence renders an individual more prone to contract acute or chronic laryngitis.

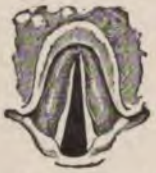

Fig. 98.—Laryngitis involving chiefly the false cords as the cause of false croup (Frühwald).

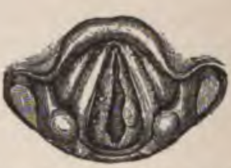

Fig. 99.—Swelling below the vocal cords from laryngitis hypoglottica chronica (after Ziemssen).

Etiology.—Hyperemia of the larynx is oftenest the result of excessive smoking, especially of cigarette smoking. It also results from working in dusty rooms and amid irritating chemic fumes.

Acute laryngitis is an acute inflammation of the mucous membrane of the larynx, sometimes extending to the submucous tissue and muscles.

Etiology.—Acute laryngitis is generally the result of exposure to wet and cold, it being in many instances simply an extension of an ordinary coryza downward. Many individuals have an hereditary or acquired tendency toward laryngeal inflammations. The affection also occurs as a complication in measles, variola, scarlatina, typhoid, rötheln and chicken-pox, and also as the result of traumatism, such as the inhalation of steam or irritating vapors. When acute laryngitis results from traumatism, the inflammation frequently assumes the edematous form of the disease, while in children the croupous form is frequently met with.

Symptoms.—The voice in almost all cases becomes almost aphonic, and its use extremely fatiguing and sometimes painful. In adults the respiration is generally unembarrassed, embarrassed respiration indicating that the inflammation is assuming the character of edema. In children, on the contrary, embarrassed respiration is often the first symptom, assuming the spasmodic character of croup. The expectoration in adults is at first clear, frothy, mucopurulent, but somewhat scanty, abundant expectoration indicating that the disease has extended to the bronchi. Expectoration in children being always very scanty probably explains why the paroxysms of dyspnea are so severe and prolonged, the pain, tickling, and sense of tightness in the throat being in them more severe. The color of the mucous membrane of the larynx as seen in the laryngoscope is always heightened, but varies in different parts of the larynx and according to the degree of the inflammation, the cords in slight attacks being quite white, while in severe attacks they are so red as to be scarcely distinguished from the surrounding parts. The ventricular bands are also sometimes so swollen as to entirely cover the vocal cords or the cords may be prevented from approximation by swelling of the posterior glottic commissure.

Treatment.—It is well to begin with the administration of a saline cathartic. The patient should remain in a warm room, avoid using his voice, and draw into the larynx every two hours the spray from an atomizer containing a 1 : 10,000 solution of adrenalin. This is readily done by the patient inserting the nozle of an atomizer in his mouth and inhaling deeply as he presses the bulb of the atomizer. The patient will feel the spray enter his larynx and should continue the use of the atomizer until the laryngeal mucous membrane is well covered by the spray. An application should be made to the interior of the larynx once or twice each day of a sedative and slightly astringent powder (Formula 119) by means of a powder-blower (Fig. 33). In making such an application to the interior of the larynx the patient is requested to grasp the tip of his tongue with a napkin and hold the tongue well forward. The operator, holding the laryngeal mirror in his left hand, introduces the mirror into the fauces in such a manner that he sees the reflected image of the glottis. The powder-blower should be held in the operator's right hand, and its nozle is placed in the pharynx in such a position that it is seen reflected in the laryngeal mirror, and moved until it is observed to point toward the glottis. The patient is requested to say "a," and at the same instant the powder should be blown from the powder-blower into the larynx. When an individual says "a" or, indeed, makes any other sound with his vocal organs, the cords are brought together in order to produce it, so that any application made at that instant is limited to the part of the larynx above the cords. Should it be deemed necessary to apply the powder to the larynx below the cords, it may be accomplished by using the powder-blower while the patient holds his breath, or the powder may be carried deep into the bronchi if the powder-blower be used while the patient is inspiring. After the more acute stage of the disease has passed, Formula 117 or even 116 should be used instead of Formula 119 as an application to the interior of the larynx. In the more severe cases powders of any kind are not well borne, and under such circumstances sprays of cocain, adrenalin, and menthol-camphor-albolene should be employed.

The application of cold or heat to the skin over the larynx gives decided relief in the more severe cases. As to the selection of heat or cold, the sensations of the patient would seem to be the best guide. In the writer's experience heat is usually the more grateful. Cold may be applied by means of a Leiter coil, a small ice-bag, or a napkin wrung out of ice-water and applied to the neck over the larynx. It should be changed sufficiently often to maintain the degree of cold desired.

Heat may be utilized by applying a Leiter coil upon the skin over the larynx in the usual manner and allowing hot water to flow through the coil. A folded napkin should be placed under the coil to protect the skin, and the temperature of the water should be as high as can be borne comfortably by the patient.

The more severe forms of acute laryngitis, fortunately rare, will require careful watching, and the physician should be prepared to prevent suffocation from edema by scarifying the epiglottis or, if necessary, by intubation or tracheotomy.

Subacute laryngitis is an inflammation of the mucous membrane of the larynx less severe than the acute.

Etiology.—Subacute laryngitis commonly results from the same causes as the acute form of the disease. It generally attacks individuals of feeble constitution or it may result from neglecting to treat properly the acute affection. Usually slight dyspnea and hoarseness are prominent symptoms. The former, generally worse at night, sometimes occasions the patient alarm. Feeble individuals, especially children who spend most of their lives indoors, are more liable to attacks of this disease than the robust and those who are much outdoors. A frequent predisposing cause is the admixture of the products of combustion with the hot air supplied from furnaces. A careful supervision of the workman each fall when the furnace is put in order for the winter, to make sure that the parts of the fire-box are fitted too tightly to allow any escape of carbon-dioxid gas int the hot-air chamber, will sometimes prevent every member of the household suffering from recurrent attacks of sore throat during winter.

Dusty occupations and the frequent inhalation of irritating fumes produce chronic laryngitis and acute exacerbations of the inflammation. By far the most common cause is exposure to cold. However, it is not usually normal respiration of cold air that is responsible for attacks of acute laryngitis, because as long as the nose is normal the air inspired through it is moistened and its temperature raised sufficiently to render it harmless to the larynx. This is not the case in individuals whose noses are sufficiently abnormal to necessitate mouth-breathing, and it is somewhat curious to note in this connection that during the first few years of a chronic nasal catarrh each cold is essentially nasal; but in the later stages of the disease the brunt of such attacks is borne by the larynx and trachea. This is probably not due to an extension of the catarrhal disease by continuity of surface, but to increasing hypertrophy of the turbinated bodies, rendering the individual a mouth-breather as soon as he inhales cold air. Many individuals take cold through their feet. The ground is a better conductor of heat than the atmosphere and, therefore the soles of the shoes should be of heavy material. The shoes should be loose about the ankles, so as not to impede the circulation, and so constructed as not to prevent the evaporation of moisture. A dentist friend and patient informed the author that he suffered for years with cold feet until he adopted the plan of wearing low shoes the entire year. During the winter his woolen underdrawers were made long enough to extend over the ankles and protect them. He wore cotton or light wool stockings.

Treatment.—The treatment is similar to that of acute laryngitis. A most important part of the treatment of acute laryngitis is rest, especially of the inflamed larynx. All unnecessary talking should be avoided and no effort made to talk above a whisper. In the case of singers, orators, and actors, where it is of the utmost importance that a normal voice should be regained as speedily as possible, absolute rest in bed in a warm room will do much to hasten the desired result; $\frac{1}{8}$ gr. of calomel with 5 gr. of bicarbonate of sodium should be given every hour until six doses have been taken or the bowels freely moved. If the attack is of sufficient severity to cause some elevation of temperature and a hot, dry skin, 1-drop doses of tincture of aconite root should be given every fifteen minutes until three or four doses have been taken, and then every hour until the skin has become moist. Of the other internal remedies, yerba santa usually yields the most speedy and satisfactory results, especially in cases accompanied by fever and a hot, dry skin. A pill containing 1 or 2 gr. of the extract combined with $\frac{1}{100}$ gr. of strychnin should be given every two hours. The patient should inhale the spray from an atomizer containing a 1 : 10,000 solution of adrenalin every one or two hours.

Cocain and antipyrin have sedative and astringent effects upon the inflamed mucous membrane of the larynx. The application of the former gives relief for only half an hour, and is followed by increased congestion. The effect of cocain can be maintained by frequent instillation of the drug or by following its use by a spray of antipyrin, which will maintain the local sedative effects of the cocain in many instances for from two to four hours.

After the more acute stages of the disease have passed, and in the milder attacks of hoarseness affecting singers, mineral astringents yield better results than adrenalin, and the spray from an atomizer containing a 2 to 4 per cent. solution of alumnol may be inhaled by the patient every hour or two with decided advantage. In singers and actors with slight laryngitis the neurotic element plays an important part, and voice failure when on the stage is largely due to nervousness and fear. Under such circumstances a pill containing $\frac{1}{20}$ gr. of strychnin or a teaspoonful of the

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fluidextract of coca in a glass of sherry wine, taken immediately before the curtain rises, will do much to secure a satisfactory control of the voice during the performance.

Chronic laryngitis is a chronic inflammation of the mucous membrane of the larynx.

Etiology.—It is generally the result of faulty use of the voice by singers or public speakers, and also of excessive smoking, especially cigarette smoking. The smoking of cigarettes is particularly injurious, not on account of the paper wrappers or any peculiarity of tobacco, but from the habit all cigarette smokers soon acquire of inhaling the smoke and bringing it directly into contact with the sensitive mucous membrane of the larynx. It is the very "mildness" of the smoke from cigarettes, in comparison with cigar smoke or that of a pipe, that makes them more injurious. The convenience and cheapness of cigarettes also causes the cigarette smoker to light a cigarette whenever he has a few moments to spare and under circumstances when he would not think of smoking a cigar or a pipe, the ill effects of which are generally confined to the pharynx. Dusty occupations and the frequent drinking of undiluted distilled liquors are also causes of the disease, while the affection is sometimes simply the expression of the rheumatic diathesis. The presence of tumors inside the larynx usually is the result rather than the cause of chronic laryngitis.

Symptoms.—The voice, as a rule, is chronically hoarse, but the degree of hoarseness varies materially from time to time. In singers the injury to the voice will be manifested in loss of range, diminished endurance, and loss of control. As the disease advances, all vocal efforts will be obviously strained and labored. Cough is by no means a constant symptom. The secretion is at no time very great in amount and diminishes as the disease advances. It is thick, starch-like, and tenacious. Small amounts of mucus frequently collect in the interarytenoid space and, being suddenly detached by coughing, are thrown out through the mouth to a considerable distance, while little bridges of mucus are sometimes seen with the laryngoscope extending from cord to cord. There is a constant feeling of constriction, as of a foreign body in the air-passages. Upon inspection certain portions of the mucous membrane of the larynx appear redder than normal; and sometimes the entire mucous membrane of the larynx is of a uniform red color, with the exception of the cords, which may be somewhat lighter in color than the surrounding parts. The mobility of the cords is frequently impaired, either from swelling of the mucous membrane covering the arytenoids or from slight muscular pain. Erosion of the interarytenoid space is frequently seen.

Prognosis.—Recovery from chronic laryngitis is always slow, and depends upon the faithfulness with which the treatment is carried out.

Treatment.—Constitutional remedies, except in rheumatism of the larynx, are not of the greatest importance; but, as in every other chronic affection, the general health should be improved as much as possible. Local treatment consists of the application by the patient several times a day to the affected mucous membrane of a sedative or astringent solution by means of the spray of an atomizer, a 4 per cent. solution of alumnol being especially useful for this purpose.

As an office treatment, applications of argyrol (10 per cent.) twice a week sometimes yield excellent results, and the occasional application of nitrate of silver solution in obstinate cases is very beneficial. The use of the remedy requires some care, and a very little of the solution should be used until it is ascertained that its use is not followed by spasm of the glottis. Most larynxes will stand the application of a cotton-tipped applicator dripping with a 2 per cent. solution of silver nitrate, and 10 per cent. solutions can be employed cautiously. The unusually slight irritation produced by the application of even the weaker solutions sometimes lasts for several hours, but is followed by decided relief of hoarseness and congestion of the parts.

In the more severe cases pain, congestion, and hoarseness are sometimes quickly relieved by the insufflation of powdered orthoform or antipyrin. A milder astringent powder consists of 1 part of alumnol and 2 parts of milk-sugar. It may be used with good effect in all cases of chronic laryngeal congestion. Sulphate of zinc (from 15 gr. to 1 ounce of milk-sugar up to equal parts of sulphate of zinc and milk-sugar) yields good results in some cases.

Laryngitis sicca is the result of atrophy of the glandular elements of the mucous membrane. The disease is generally associated with atrophic rhinitis and pharyngitis.

Pathology.—The appearance of the laryngeal mucous membrane is similar to that of the nose and pharynx in atrophic rhinitis and pharyngitis. In some cases the parts are simply dry and glazed, looking as if varnished; in other cases there are accumulations of inspissated mucus, often greenish in color and emitting an offensive odor, similar to that observed in atrophic rhinitis. The gross structural alterations that are seen in the nose in atrophic rhinitis are not observed in atrophic laryngitis. It is a disease characterized by diminished and perverted secretions rather than by atrophy of mucous membrane, submucous structures, and laryngeal cartilage. The masses of inspissated secretions cling to portions of the larynx where the glands are most numerous—the subglottic region and the upper surface of the ventricular bands.

Symptoms.—In cases where there are no accumulations the larynx feels dry and irritated. The voice is slightly hoarse and tires upon the slightest exertion. In cases characterized by accumulation of fetid secretions the sufferings of the patient are mainly due to the irritation produced by the presence of these secretions and by the effort to rid himself of them. His strength is exhausted by ceaseless and useless coughing, usually worse at night.

Occasionally a little mass will be ejected from the larynx with considerable violence, bringing with it a small area of laryngeal epithelium, and producing a slight capillary hemorrhage which alarms the patient. In a few cases which the writer has seen—for the disease is somewhat rare—the patients were fairly well nourished.

Treatment.—In cases where the disease is the result of atrophic rhinitis, efforts should be directed toward improving the condition of the nose, so that the important function of warming and moistening the inspired air is restored. The wearing of cylinders of absorbent cotton within the nose, as directed for the treatment of atrophic rhinitis, is also valuable in bringing about an improved condition of the laryngeal secretions.

Patients with atrophic rhinitis do well in a moist climate. In one case all laryngeal symptoms had disappeared upon the return of the patient to Philadelphia after a year's absence in the Philippines. Internally may be given stimulating expectorants or drugs, such as iodid of potassium and hydriodic acid, that increase the secretions of the upper respiratory tract and render them more fluid.

Inhalations of steam or the use of the bottle-inhaler with hot water and tincture of benzoin aid greatly the patient's efforts to get rid of the annoying laryngeal accumulations. Great relief sometimes follows spraying the larynx with equal parts of hydrogen dioxid and Dobell's solution, because the action of the dioxid upon the accumulations softens them and increases their bulk, and hence aids their expulsion from the larynx. The irritation of the larynx is best controlled by spraying the parts with a 2 per cent. solution of antipyrin.

Inflammation of the Submucous Tissue of the Larynx.—Acute edema of the larynx usually is the result of phlegmonous inflammation with infiltration of the surrounding submucous tissue, frequently endangering life by occlusion of the rima glottidis.

Etiology.—Edema of the glottis may result from traumatism, such as the swallowing of corrosive liquids. It occurs rarely as a primary affection, resulting from exposure to cold and wet in persons of debilitated constitution and also as a neurosis. In most instances, however, the disease is secondary, and results from syphilitic or tuberculous perichondritis (Fig. 100), retropharyngeal abscess, Bright's disease, glycosuria, etc.

Pathology.—The infiltration consists essentially of a serous or seropurulent fluid, most abundant beneath the mucous membrane of the ary-epiglottic folds, the ventricular bands, and the ventricles. The submucous tissue is most abundant in those regions of the larynx, but the edema is not always limited to that part of the larynx above the vocal cords, but may extend to the submucous tissue beneath the vocal cords. Infraglottic edema, as the disease is then called, is almost invariably secondary in its origin and always serous in character (Fig. 99).

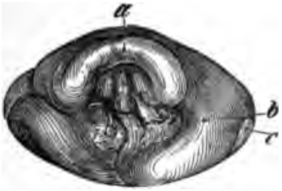


Fig. 100.—Phlegmonous laryngitis, with phthisic ulcer: *a*, Epiglottis; *b*, left aryepiglottic fold; *c*, left pyriform sinus (from v. Ziemssen, after Türck).

Symptoms.—In some cases there are no symptoms whatever prior to a fatal suffocation or syncope. The voice is usually rough and deep or altogether lost, due to thickening and heaviness of the cords. In the early stages of an attack the chief difficulty in breathing is during inspiration, but as the disease advances respiratory distress increases, with the result of producing complete apnea. A short cough is present and deglutition is both difficult and painful. When the edema is considerable the sense of suffocation is most oppressive. With the laryngoscope edema is quickly recognized, the infiltrated portion of the larynx being greatly swollen and semitransparent in appearance. When the edema is subglottic the swollen mucous membrane of that region will almost always be seen of a more intense red than the cords above.

Prognosis.—Recovery from severe primary edema is always doubtful, and the prognosis in secondary edema depends upon the circumstances of the primary cause of the disease. The patient can hardly be said to be out of danger under two or three weeks from the commencement of an attack, and may even then become the subject of chronic infiltration. When death occurs it is almost always the result of carbonic acid poisoning, and may be the direct effect of stenosis or spasm of the glottis. Another danger is the possible occurrence of suppuration—abscess of the larynx.

Treatment.—Free diaphoresis should be produced in suitable cases by the hypodermic use of $\frac{1}{12}$ to $\frac{1}{4}$ gr. of pilocarpin or free catharsis with croton oil, or eserin hypodermically if the patient is unable to swallow. The temperature of the room in which the patient lies should be carefully regulated, and cold, dry applications kept upon the throat over the larynx. As soon as edema is seen within the larynx, local scarification with the laryngeal lancet (Fig. 101) should be performed. If, in spite of scarification and the use of pilocarpin, edema continues, with increasing respiratory distress, general enfeeblement, and symptoms of carbonic acid poisoning, intubation or tracheotomy should be performed at once. Many lives probably have been sacrificed by hesitation and delay.

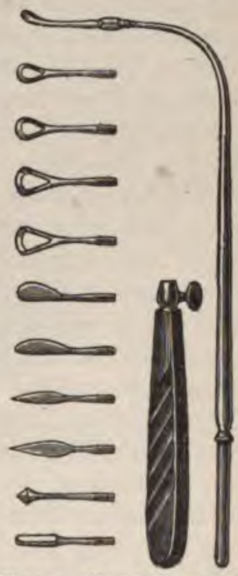


Fig. 101.—Heryng's laryngeal lancets, knives, and curets.

Laryngitis syphilitica is an inflammation of the larynx due to syphilis.

Etiology.—Syphilis of the larynx most frequently occurs as a manifestation of the tertiary period three to many years after the primary infection. As a manifestation of secondary syphilis laryngeal symptoms may occur within a few weeks or may not appear until two or three years after syphilis has been contracted.

Pathology.—In secondary syphilis the laryngeal symptoms may consist of a mere hyperemia, giving rise to the symptoms of simple laryngitis. Ulcerations may also be present and are usually symmetric, that is, if an ulcer is present upon one part of the larynx, there is usually a similar ulcer also upon the corresponding part of the opposite side of the larynx. Syphilitic warts or condylomata also are found in the larynx during the secondary stage of syphilis. They may undergo ulceration or disappear spontaneously. Tertiary manifestation consists of gumma, which may break down and cause deep ulcerations, with perichondrosis and necrosis of the cartilages; while stenosis may result from cicatricial contraction after the healing of syphilitic ulcers.

Symptoms.—The patient usually first complains of a slight hacking cough, hoarseness, and sometimes difficult and painful deglutition. Inspection with the laryngoscope reveals some of the lesions already specified.

Diagnosis.—The disease may be mistaken for tuberculosis, malignant disease or other neoplasms, scleroma, atrophic laryngitis, and simple chronic laryngitis.

Treatment.—Constitutional remedies already mentioned (see Syphilitic Rhinitis) should be employed. Alumnol or some other astringent should be prescribed for the patient's use at home, in the same manner as for simple laryngitis, while an application of Formula 118 should be made to the interior of the larynx every other day with the powder-blower. If shallow ulcers are present they should be touched each day with 12 per cent. nitrate of silver solution. After a time, when the process of repair is beginning to set in, these applications become painful and should be omitted, but insufflations of Formula 118 should be continued until the larynx presents its normal appearance. Should partial stenosis occur as the result of cicatricial contraction, the laryngeal stenosis may be overcome by the use of laryngeal bougies or some suitable cutting instrument.

Tubercular laryngitis is a chronic laryngitis due to the presence of the tubercle bacilli.

Etiology.—It is generally secondaryto pneumonic phthisis. In most all instances the cellular tissue of the larynx is the structure first affected. The inoculation in this locality may occur through the lymph-channels, the blood-vessels, or by means of an abrasion in the mucous membrane exposed to tuberculous sputum from the lungs. Inoculation of tuberculosis in syphilitic ulcers in the larynx has been observed, and it is stated that the presence of simple catarrhal laryngitis, either acute or chronic, is a predisposing cause of tuberculous laryngitis when tuberculosis of the lungs is already present. Hospital reports, mostly German, vary from 6 to 50 per cent. as to the frequency of laryngeal involvement in postmortems on individuals dead from pneumonic phthisis. Probably about one-third of the cases of lung consumption in this country, sooner or later, develop laryngeal lesions. That the larynx is not frequently inoculated by the inspiration of pulverized dried phthisic

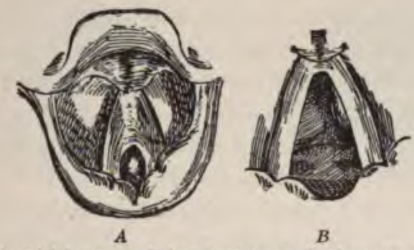


Fig. 102.—*A*, Cicatricial stenosis before treatment; *B*, the same after use of cutting dilator (Lennox Browne).

sputum is probably due to the fact that under ordinary circumstances particles of dust in inspired air are arrested within the nose or pharynx and do not reach the larynx; and in this connection it is interesting to note that those suffering from atrophic rhinitis are proportionately more frequently attacked by pneumonic phthisis than those with normal noses. More frequently tuberculous lesions of the larynx occur on the same side as the lung most affected by the disease, although this is not invariably the case.

Pathology.—The lesions in the larynx are similar to those found in tuberculosis elsewhere: Tubercles are formed and the bacilli are disseminated into the surrounding tissues, partly by their own multiplication and partly by lymph-currents, so that the extent of the tissue involvement is always much greater than it appears to the eye of the observer. As the result of nature's efforts to limit the spread of the affection, leukocytes appear about the affected area and a reticulum of connective tissue is formed. . Degeneration of the tubercle then occurs as the result of lack of nutrition, and manifests itself as a tissue necrosis, with an ulcer that may involve not only the mucous membrane and cellular tissue, but also muscles and cartilages as well. Bacilli appear in the discharges and the tuberculous process extends.

In tuberculous individuals there is often observable an ashy gray appearance, differing from the ordinary paleness of anemia of mucous membranes at the junction of the hard and soft palate. The same color is also less frequently observable in the larynx. There is sometimes slight localized congestion of the cords, one of which may be partially paralyzed and sluggish in its movements from the pressure of a hypertrophied tuberculous lymphatic upon the recurrent laryngeal nerve. The voice under such circumstances is somewhat aphonic and perhaps slightly hoarse at times.

Characteristic lesions are submucous infiltrations, generally club-like in shape, sometimes involving one or both arytenoids, "pyriform arytenoids" (Fig. 103), or producing the "turban-shaped" epiglottis. Minute tubercles break down upon the cords, producing ulcers that give the cords a "moth-eaten" appearance (Fig. 104). Fungus-like thickening of the interarytenoid mucous membrane is common in laryngeal tuberculosis. Deep ulcerations involving necrosing cartilage is a later stage, from which there are few recoveries. Usually the concomitant lung lesions have also reached an advanced stage, and the fatal end is hastened by the patient's inability to swallow or even breathe without pain.

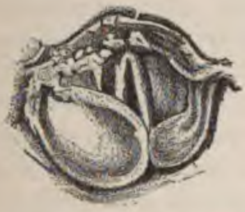


Fig. 103.—Laryngeal tuberculosis with characteristic pyriform swelling of the arytenoid cartilages (Lennox Browne).

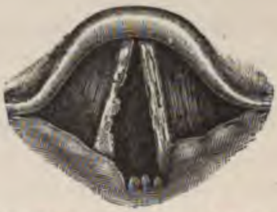


Fig. 104.—First stage of tuberculosis of larynx. Ulceration of right cord and swelling of interarytenoid region with formation of folds. May be early ulceration here (Sahli).

Differential Diagnosis.—In certain cases the differential diagnosis between malignant ulceration and tuberculosis is one of extreme difficulty. In malignant ulceration the inflamed and reddened appearance of the unaffected mucous membrane of the larynx contrasts strongly with the pale and anemic appearance in tuberculosis. There is the lung involvement in tuberculosis, the greater involvement of the cervical glands in malignant disease. There are two other conditions of the larynx that sometimes closely simulate tuberculosis in appearance—syphilis and lupus.

It should be borne in mind that tuberculosis is sometimes engrafted upon a syphilitic ulcer. Syphilitic ulcer of the larynx follows the breaking down of a gumma. There is usually a history of syphilis or syphilitic lesions may be found upon the body elsewhere. The diagnosis will be cleared up by the Wassermann reaction and tuberculin tests. Iodids must not be used, as tuberculous individuals do badly under even small doses.

Lupus is tuberculosis of the larynx resulting from the inoculation of the larynx with an attenuated tubercle bacillus. It is usually secondary to lupus of the mouth or pharynx, and is an extremely rare disease.

Symptoms.—In the earlier stages of the disease there are practically no symptoms except perhaps occasional transitory hoarseness or very slight aphonia. These voice symptoms increase as the disease progresses until the voice may be a mere whisper and very hoarse. The interference with vocalization may be due to pressure upon the recurrent laryngeal nerve, interarytenoid thickening interfering mechanically with the approximation of the cords, tubercular infiltration of the muscles or involvement of the arytenoid articulations or ulcerations upon the cords.

A hacking, dry cough is often present when there is interarytenoid thickening. When ulceration is present the secretions are more abundant and contain the tubercle bacillus. The secretions are sometimes streaked with blood, but abundant hemorrhage from tubercular ulcerative laryngitis probably never occurs.

Pain on swallowing occurs where the infiltration of the arytenoids or epiglottis is great, and there is a sense of obstruction on deglutition. Deglutition becomes exquisitely painful when ulceration has occurred upon the epiglottis or in the aryepiglottic fold. Ulceration within the larynx gives rise to little or no dysphagia and liquid gives rise to less pain than solid food. So exquisitely painful is the act of swallowing in some cases that patients have been known to refuse food or drink for days rather than endure the torture of swallowing it.

Prognosis.—Cures have been reported even in the ulcerative stage of the disease, but the progress of the disease in all cases is usually slow and tedious. Harland states that the chances of improvement in tuberculosis of the larynx are nearly as follows:

"1. Larynx free from disease; prognosis so far good. 2. Congestion of cords (vasomotor); prognosis good; examination of lungs indicated. 3. Superficial ulcer, localized infiltration or tuberculoma; chances of improvement about 60 per cent. 4. Deep ulceration; chances of improvement about 38 per cent. 5. Lesions of vocal cord, ventricular band, or interarytenoid fold; chances of improvement about 89 per cent. 6. Lesions of epiglottis or aryepiglottic fold; chances of improvement about 29 per cent."

Treatment.—The treatment of the milder forms of the disease should be largely systemic. It should be borne in mind that the disease only does great harm when it causes pain or prevents the taking of food, and that occasionally large ulcers have been seen to heal with practically no local treatment. Cutting operations, with the expectation of eradicating the local disease, are probably, in most cases, worse than useless, as it is impossible to know how far the bacilli have penetrated the apparently sound tissue about a lesion. Of course, if tubercle papilloma in the interarytenoid or other regions attain such a size as to produce dyspnea, as they rarely do, an effort should be made to remove them; otherwise those growths should be let alone. They frequently recur after removal.

Ulcerations should be cleansed with equal parts of Dobell's solution and hydrogen peroxid by means of a spray from an atomizer. After the parts have been cleansed the ulceration should be dusted by means of a powder-blower with Formula 119.

Owing to the bulk of the tannic acid contained in this powder the amount of morphin in the quantity thrown by the powder-blower into the larynx is very minute, but if for any reason the morphin is objectionable, it may be omitted from the formula.

Excessive pain on swallowing may, of course, be relieved by cocainizing the larynx, either with an atomizer or a laryngeal applicator. A lozenge containing ¼ to ½ gr. of cocain, dissolved in the mouth before meals, yields fairly satisfactory results. However, for the relief of painful deglutition no remedy yields such satisfactory results, everything considered, as orthoform.

This nearly insoluble substance has the property of producing analgesia when applied to exposed nerve-endings. It is, therefore, especially valuable as an application to irritable ulcers after they have been cleansed with Dobell's solution and hydrogen peroxid. Its anesthetic effects are increased by a previous application of a solution of cocain and persist for four or five hours. When insufflated into a tuberculous larynx the powder produces a momentary smarting, followed by analgesia more or less complete, which persists as long as the powder adheres to the abraded surface or an ulcer. The powder possesses decided antiseptic qualities and promotes the healing of tuberculous ulcerations.

Of the other antiseptic powders, omorol, an albuminate of silver, seems to give the best results. It should be insufflated into the larynx at intervals of one or two days.

A nurse or one of the patient's friends can be taught to insufflate orthoform into a tuberculous larynx ten minutes before each meal, and in many instances thus secure complete relief from dysphagia. Orthoform is said to be non-toxic, and hence may be used locally in liberal quantities. It may, of course, be prescribed in the form of a lozenge, but with not nearly as satisfactory results as when the powder is insufflated into the larynx.

A 1 to 2 per cent. spray of menthol in albolene may be used by the patient, inhaling each time he compresses the bulb of the atomizer. It yields fairly satisfactory results in a few cases. However, before using any application to the larynx himself the patient should, of course, cleanse it as thoroughly as possible under the circumstances by inhaling the spray from an atomizer containing equal parts of Dobell's solution and hydrogen peroxid.

When other methods fail, injections of $\frac{1}{5}$ of 1 per cent. cocain in alcohol into the superior laryngeal nerve may be tried.

The patient is placed in the prone position, with the head and neck slightly extended and the chin turned away from the point of injection. The larynx is pressed away from the midline by the thumb and made to project on the side to be injected. The nerve is marked out by the nail of the index-finger, which is placed between the hyoid bone and the thyroid cartilage and immediately above the superior thyroid tubercle, where a tender spot is found. The blunt needle is now pushed in with a jerk at right angles to the surface and at the middle of the finger-nail to a depth of $1\frac{1}{2}$ cm., and carefully moved so as to seek the spot at which the patient complains of pain in the ear. A few drops of the solution of alcohol are injected, and if there is a violent fit of coughing it indicates that the needle has possibly entered the pharynx and is too deep, but this condition very rarely happens. Finally, the slightly warmed alcoholic solution is injected until the pain in the ear has ceased.

Fluids, especially if iced, commonly cause much less pain on swallowing than solids, and iced milk can sometimes be taken through a tube with the patient's head hanging over the bed when it would be much more painful to sit up and drink the fluid; but in extreme cases the stomach-tube and rectal alimentation will have to be employed.

Syrupy lactic acid is a remedy that is said to have the property of destroying tuberculous structures without attacking the surrounding sound tissues. Its application to a tuberculous ulcer is so painful that its use should always be preceded by thoroughly cocainizing the larynx with a 10 per cent. solution of cocain. The applications can be made at intervals of four or five days and be preceded, if necessary, by cureting the cleansed ulcer. It is best to commence by lightly touching the parts with a 25 per cent. solution of the syrupy acid and gradually increasing the strength from visit to visit as the patient becomes accustomed to the pain. The remedy undoubtedly hastens cicatrization of ulcers and promotes absorption of deposits.

Leprosy of the Larynx.—According to Hollman, among the earlier symptoms are hoarseness and loss of voice. The laryngeal condition is usually an extension of the pharyngeal and nasal inflammation. In the great majority of cases there is a hypersensitiveness of the larynx instead of anesthesia. Inspection shows the hyperemic mucous membrane of the arytenoids and the aryepiglottic folds, early becoming studded with small yellowish-white lepra tubercles and ulcerations. The false cords are swollen, obscuring the true cords. In a few cases leprous ulceration of the epiglottis occurs. In other cases small tubercles in the intra-arytenoid space and on both the true and false cords appear, and, like all leprous tubercles, thicken and indurate the surrounding tissues, then ulcerate.

In some cases the leprous tuberculous growths in the larynx become so great as to completely fill its cavity, necessitating immediate tracheotomy.

Treatment consists in the use of eucalyptol spray, with insufflation of orthoform, or a 5 per cent. spray of protargol.

Benign Tumors of the Larynx.—The tumors most commonly met with are papilloma, fibroma, angioma, myxoma, and cyst.

Symptoms.—The most notable symptom is mechanical obstruction to breathing and phonation proportionate to the size and location of the growth. If the tumor is small and situated upon a vocal cord, dysphonia results from interference with its vibration, while, if the growth is situated in the anterior commissure between the cords, aphonia results from the tumor preventing their approximation. If, however, the tumor is small and situated above the vocal bands, but slight, if any, subjective symptoms will be noticed. With the growth of a laryngeal tumor, dyspnea increases and asphyxia may suddenly occur unless prompt relief is at hand. Cough is not usually present unless the growth is of such a character as to vibrate in the breath current and titillate the interior of the larynx (Fig. 105), when cough and laryngeal spasms may occur. Chronic laryngitis is usually present.

Papillomata found in the larynx of children offer some peculiarities. They are soft and usually multiple. They are usually associated with catarrh of the nasopharynx and hypertrophied tonsils, and sometimes disappear under the application of astringent powders to the larynx and successful treatment of the nasal and pharyngeal affection, to the existence of which in many instances they seem largely due.

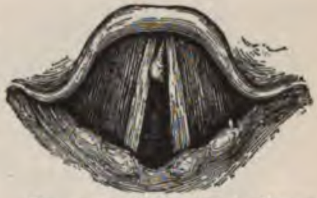


Fig. 105.—Pedunculated fibroma upon the under surface of the left vocal cord; position during inspiration (v. Ziemssen).

The papillomata of the adult are harder than those of children, and are usually situated on the vocal cords or ventricular bands.

Etiology.—Any long-continued irritation of the laryngeal mucous membrane may result in hyperplasia and the growth of warts. When the result of long-continued catarrhal inflammation, papillomata usually occupy the interarytenoid space and the posterior extremities of the vocal cords.

Papillomatous growths are sometimes seen about tuberculous ulcerations and upon the mucous membrane covering gummata and tumors lying underneath the laryngeal mucous membrane.

In case the papillomata occur in connection with laryngeal phthisis, syphilis, or a laryngeal tumor, they result from the irritation to the laryngeal mucous membrane caused by the primary disease.

Treatment.—Tumors springing from the epiglottis can usually be removed by means of a snare with a curved lip, while cysts may be opened with the laryngeal lancet (Fig. 101) and their contents allowed to escape, after which the end of a probe on which nitrate of silver has been fused should be passed into the cyst and its interior thoroughly cauterized. Papillomata (Fig. 106) and soft or pedunculated tumors should be removed by means of the laryngeal forceps, if necessary picking off piece after piece until the entire tumor has been removed. In every case of tumor of the larynx the emergencies of the case govern the operative procedures necessary. If the tumor is small and the operator sufficiently expert he will probably prefer the "indirect" to the "direct" method of operating. If the removal of the tumor is very urgent to prevent suffocation and the patient's throat is too irritable to permit instrumental interference without danger of fatal results from induced spasm of the glottis, tracheotomy should, of course, be performed before the removal of the tumor is attempted.

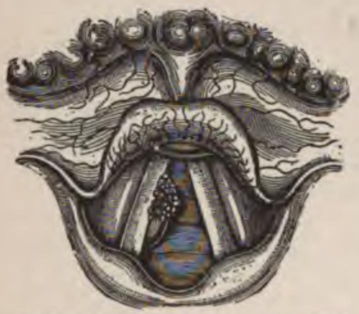


Fig. 106.—Papillomata of larynx (Stoerck).

Laryngeal carcinomata are divided into intrinsic and extrinsic. Intrinsic carcinoma attacks the ventricular bands, the ventricle, and the vocal cords, or may be subglottic. Extrinsic carcinoma has its origin upon the epiglottis, the arytenoid folds, and in the pyriform sinus.

In extrinsic carcinoma the lymphatic glands are affected almost from the commencement, the disease rapidly advances toward a fatal termination, and is rarely, if ever, cured by operation.

Intrinsic carcinoma is a less grave affection; its advance is less rapid, and the neighboring lymphatics often remain for a long time uninvolved. Extirpation, either partial or entire, should not be undertaken except the disease be intrinsic and limited entirely to the larynx.

Symptoms.—Continued hoarseness and sharp pain in the larynx, pharynx, or ear in a person over forty is sufficiently suspicious of carcinoma to render it advisable to keep the patient under observation in cases where no growth is visible by laryngoscopy, so that the all-important advantage of the earliest possible diagnosis is secured. Hoarseness grows worse until the voice is aphonic, while the growth progressively encroaches upon the lumen of the larynx until dyspnea embarrasses the patient. Cough, with the usual scanty expectoration of chronic laryngitis, is an early symptom, the expectoration becoming purulent and bloody only after the growth has begun to break down. Dysphagia is an early symptom only in extrinsic cases. In intrinsic cases the cervical lymphatics are not involved until the tumor begins to break down, those in the posterior triangle being involved first from supraglottic lesions, and those at the angle of the jaw first when the disease is subglottic.

By laryngoscopy a tumor is usually visible in the supraglottic cases, involving, at least in the early stages, usually only one side of the larynx, with paralysis of a cord, which, following Semon's law, involves first the abductors and later in the disease the adductors. Microscopic findings, if negative, are unreliable when based upon the examination of a small piece of the tumor removed by cutting forceps through the mouth, because the cancerous mass may be superficially papillomatous in appearance, both macroscopically and microscopically. Growths of this character, operated through the natural passages, have given rise to the impression that papilloma is prone to degenerate into cancer. Hence, it is better in all suspicious cases to do a thyrotomy at once even to secure a reliable specimen for microscopic examination, more especially when it is possible to remove the entire growth by this comparatively simple operation.

Treatment. — Extirpation of the larynx, either in part or as a whole, gives the best hope of cure. Malignant growths of the tonsils, pharynx, and larynx may be destroyed by fulguration or treated by radium, mesothorium, or other radioactive substances, and the progress of the growth and its more distressing symptoms controlled at least for the time. The more accessible parts of the tumor may be removed with cutting forceps either by the direct or indirect methods or laryngofissure, and the parts then treated with the *x*-ray by the double tube or cross-fire method. However, the ultimate results are not always successful.

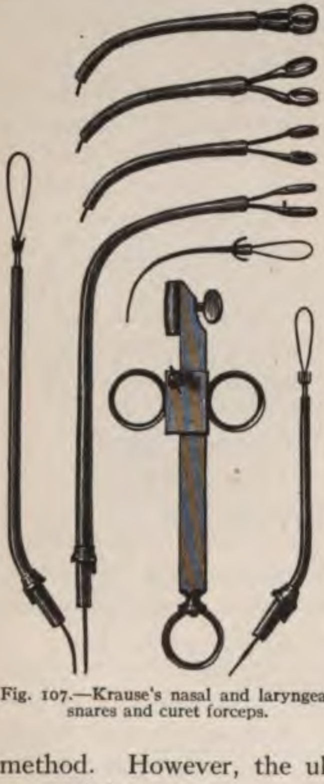


Fig. 107.—Krause's nasal and laryngeal snares and curet forceps.

Foreign Bodies in the Larynx.—Smooth substances, such as small pebbles, shoe-buttons, seeds of various kinds, etc., are not apt to lodge in the larynx, but are either removed by a fit of coughing or drop into the trachea. In a case reported by Charles Harper Baker an open safety-pin was retained in the bronchus without marked discomfort for about a year, when one-half of the pin was coughed up, and a year after the other half. Both portions were much corroded. Substances with sharp points, like fish-bones, sand-burs, or pins (Fig. 109), are often partially embedded in the tissues of the larynx.

Symptoms.—Aphonia may be the only sign of a foreign body in the larynx. Commonly, however, there is a sense of irritation or even pain, and difficult respiration, resulting either from the bulk of the foreign body or the spasm or edema its presence has caused.

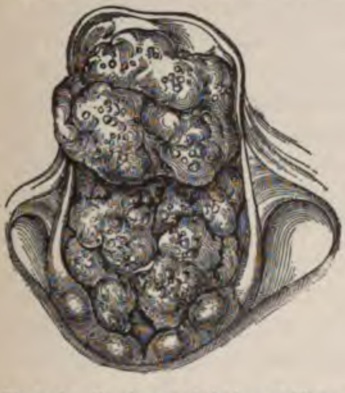


Fig. 108.—Carcinoma of the larynx (Stoerck).

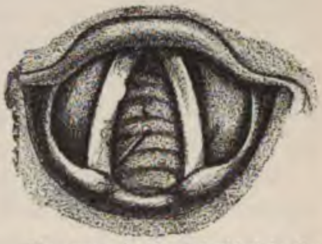


Fig. 109.—A pin embedded in the posterior portion of the right vocal cord (Seiler).

Treatment.—The foreign body should be removed with laryngeal forceps when possible either by the direct or indirect method. In rare cases a wound of the interior of the larynx is rapidly followed by edema of the glottis. Therefore, in some cases tracheotomy should be performed before an attempt is made to remove the offending substance through the natural openings, or it may be removed by thyrotomy; for it should be borne in mind that such an operation is more conservative than prolonged attempts to remove a foreign body in timid children and indocile adults, especially when the operator is also embarrassed by clumsy instruments, imperfect light, or the patient's reflex cough persisting in spite of thorough cocainization. When a bolus of food or a large substance threatens immediate suffocation, the finger should be inserted into the patient's mouth and an effort made to hook the foreign body out of the larynx. Failing in this, a horizontal incision into the larynx through the cricothyroid membrane should be quickly made. If nothing better is at hand, this may be done with a penknife, and the blade then turned vertically in such a manner as to hold open the wound and permit respiration. Subsequently the foreign body may be removed by thyrotomy; or after the insertion of a tracheotomy tube, by instrumentation through the mouth.

THYROTOMY consists in the separation of the two wings of the thyroid cartilage by means of an incision through the angle of the thyroid cartilage, thus exposing the interior of the larynx for the removal of tumors or foreign bodies that cannot be removed readily through the mouth. The operation is done under chloroform anesthesia and in the tracheotomy position.

An incision is made through the skin from the thyrohyoid space to the upper tracheal rings exactly in the median line. The underlying structures are divided carefully by means of a knife and a grooved director. The thyroid prominence bulges out of the wound and can be opened by passing one blade of a stout pair of angular scissors through the cricothyroid membrane into the larynx. The larynx can also be opened by means of a stout bistoury or, when ossified, by means of a Sajous saw (Fig. 48). The edges of the wound are now separated with retractors in the hands of an assistant, and spasm of the laryngeal muscles, which always occurs when the larynx is opened, is controlled by brushing the laryngeal mucous membrane with a 4 per cent. solution of cocain. The operation is comparatively bloodless and exposes in a very satisfactory manner the interior of the larynx for the removal of a foreign body or a tumor.

After the removal of the tumor or foreign body the severed edges of the cartilages are united by one or more catgut sutures and the skin wound brought together by sutures of worm-gut. Union usually occurs by first intention, but the ultimate condition of the voice depends upon the amount of damage done to the interior of the larynx. The removal of a foreign body or small tumor is not followed by appreciable impairment of the voice.

The after-treatment following removal of a small tumor by this method consists in keeping the patient quiet in bed for a week or so and forbidding the use of the voice. For the first few days the diet should be liquids.

NEUROSES OF THE LARYNX

Neuroses of the larynx are divided into sensory and motor neuroses.

Sensory neuroses are anesthesia, hyperesthesia, and paresthesia.

Anesthesia of the mucous membrane of the larynx, sometimes accompanying motor paralyses of the larynx, is occasionally observed in hysteria and in the insane.

Hyperesthesia accompanies all forms of laryngeal inflammation except some forms of early tuberculosis. It is frequently present in neurotics.

Paresthesia manifests itself chiefly as a sensation of choking or as of a foreign body in the larynx of hysteric individuals.

These sensations are sometimes the result of disease of the pharynx or tonsils, and when this condition exists it should receive appropriate treatment. In the meantime considerable relief will follow the administration of 10 to 15 gr. of the bromid of sodium three times a day.

Motor neuroses are spasm incoördination and paralysis of the laryngeal muscles.

Spasm of the laryngeal muscles appears in three forms—spasmodic cough, spasm of the adductors, and spasm of the tensors of the cords.

Spasmodic laryngeal cough or **laryngeal chorea** is a condition commonly described under this heading, although other respiratory muscles beside those of the larynx are involved in the paroxysms of coughing, which is of a peculiar bark-like character resembling that of a big dog. The paroxysms of cough occur at frequent intervals during the day, but cease during sleep. The disease occurs more frequently in neurotic females than in males. It is not associated with chorea in any manner whatever, nor is there any evidence of laryngeal inflammation on examination with the laryngoscope.

Treatment should be directed toward improving the individual's health. Good results follow the prolonged use of some nerve tonic like pil. sumbul comp., one after meals and at bedtime, but quicker relief can generally be obtained from bromid of sodium, 10 to 15 gr., after meals and at bedtime.

The use of the induced current, one sponge on the skin on each side of the larynx, does good probably from the impression it makes on the mind of the patient. To accomplish this the electricity should be used as strong as it well can be borne by the patient. Aside from the use of electricity, local treatment is not indicated.

Spasm of the Tensors of the Vocal Cords.—This is a rare condition affecting singers, actors, and orators, somewhat analogous to the spasm of the muscles observed in the muscles of the hand in writers' cramp.

Symptoms.—The voice is suddenly lost, possibly in the midst of a sentence, by a spasm (sometimes painful) of the cords. The greater the effort to speak or sing, the tighter and longer the spasm. After a moment the spasm subsides and the voice is normal for several minutes, when another spasm may occur. Examination with the laryngoscope during a spasm shows the cords tightly approximated in the position for vocalization. There may or may not be slight hyperemia of the larynx.

Treatment consists in rest of the voice, preferably in the country or at the seashore, tonics, and attention to personal hygiene.

Spasm of the adductor muscles or **laryngismus stridulus, false croup,** generally involves the crico-arytenoidei externi and the arytenoideus.

Etiology.—The condition usually occurs in neurotic children under three years of age. There is frequently some pathologic condition of the nose and nasopharynx that renders the nerve-endings of the upper respiratory tract more irritable, and in neurotic children is sufficient to induce a reflex spasm of the adductor muscles of the vocal cords from trifling causes, such as a slight lowering of the temperature during the night after the child has gone to bed, kicking off the bedclothing, etc.

In some adults the entrance of a small particle of food or dust into the larynx produces a condition similar to laryngismus stridulus. In such individuals applications to the nasopharynx of iodin-potassium-iodid-glycerin; solutions of sulphate of zinc or any of the other routine applications to the nasopharynx may be followed by alarming spasms of the laryngeal adductor muscles if a drop of the solution by any mischance happens to drip into the larynx. The same thing occurs in such individuals after the application of an ordinary remedy to the larynx.

Even to the experienced laryngologist the *symptoms* are sufficiently alarming. After the laryngeal application the patient suddenly becomes cyanosed and, with protruding eyeballs, clutches at his throat. The patient gasps. The respiration is loudly "crowing," like that of a child with laryngismus stridulus, and death from suffocation seems imminent. These alarming symptoms disappear as suddenly as they occurred if the patient makes an effort to pronounce words. The practitioner in a loud voice should command the patient to say "One, two, three," or in an equally loud and commanding voice inquire "What is your name?"

When the patient makes an effort to answer, the spasm of the glottis vanishes and breathing becomes at once normal.

In the first stage of locomotor ataxia there is occasionally a history of spasms of the adductor muscles resembling laryngismus stridulus, and in an adult such a history in the absence of foreign bodies gaining entrance into the larynx should be of sufficient warrant to search for other symptoms of this disease. In young children enlargement of the thymus gland may be the cause of dyspnea and death from pressure on the trachea, pneumogastrics, and large venous trunks. The symptoms are expiratory as well as inspiratory stridor, which may suddenly assume a dangerous character with labored respirations; the patient blue or almost black. Consciousness is lost and the patient quickly dies in convulsions. Diagnosis is most certainly made by means of the *x*-ray, and while three infants seen by the author recovered under adrenalin spray and expectant treatment, the removal of a sufficient portion of the sinus gland to prevent injurious pressure is the most certain method of preventing a fatal termination.

Symptoms.—Laryngismus stridulus appears suddenly during the night in apparently healthy children. The child sits up in bed gasping for breath. At the height of the attack it is markedly cyanosed, when suddenly there is a deep inspiration and the symptoms rapidly disappear. There remain no symptoms of laryngeal inflammation except that during the day there may be a slight "croupy" cough.

Prognosis.—The attacks of false croup not infrequently recur at intervals for weeks and months. It is said that in very young children the attacks sometimes terminate in eclampsia or convulsions.

Treatment is directed to the prompt relief of the laryngeal spasm. This can sometimes be accomplished by making the child sneeze by tickling the nose with a feather or a pinch of snuff. When sneezing occurs the spasms cease.

The inhalation of a few drops of chloroform from a handkerchief is generally effective. Extreme heat or cold to the skin over the larynx or 3 drops of adrenalin chlorid solution (1 : 1000) hypodermically will sometimes relieve the spasm. Any or all of these measures should be tried while a hot mustard-bath is being prepared. Then it should be placed in this and, after remaining for a few moments, taken out and carefully wrapped in a warm woolen blanket before being replaced in bed. For very severe attacks Coakley advised the following as a rectal injection:

℞.	Chloralis hydratis	gr. vj;
	Potassæ bromidi	gr. x;
	Aquæ	q. s. ad. f℥j.—M.

Sig.—Use as a rectal injection for a child six months old.

As a prophylactic between the attacks all sources of irritation should be sought for and removed. These may include errors of digestion, carious teeth, or nasopharyngeal disease. Hearty suppers and lunches at bedtime should be forbidden.

Sodium bromid in 5-gr. doses should be given every three hours during the day for a week or more until the immediate danger of a recurrence of the attack seems to have disappeared. The child should then take syrup of iodid of iron after meals, 1 drop for each year of its age, up to 10 drops, with or without cod-liver oil. Syrup of the hypophosphites may be substituted for the iron at the physician's discretion. In adults, pil. sumbul comp. or some other combination of iron, valerian, and asafetida may be given.

Laryngeal Vertigo or Epilepsy.—This is a rare laryngeal neurosis occurring more frequently in males than females.

Etiology.—The disease occurs in neurotic individuals, and the symptoms are probably due to an incoördination of the respiratory centers implicating the laryngeal muscles in such a manner as to produce closure of the glottis.

Symptoms.—The prodromes are a tickling sensation in the larynx and a fit of coughing. The patient draws a long breath. The glottis closes and the inspired air is confined in the lungs. There follows vertigo, cyanosis, and sometimes loss of consciousness. The "fit" then passes off, to be repeated at intervals.

The laryngoscope shows no characteristic lesion, a normal larynx or slight catarrhal inflammation being commonly observed. Disease of the nose and pharynx catarrhal in character is frequently present in such cases.

The *prognosis* as regards life is favorable. There may, however, be a recurrence of the attacks of laryngeal vertigo extending over a period of years.

The *treatment*, like that of other neuroses, consists in hygienic measures calculated to improve the individual's general health, and if the attacks are frequent the administration of antispasmodics. Galvanic electricity, the positive pole over the larynx, may be employed.

Paralysis may affect but one laryngeal muscle or pair of muscles; or it may affect several of them at once, and may be either unilateral or bilateral. Paralysis of the larynx may be divided clinically into paralysis of the adductors, paralysis of the abductors, and paralysis of the tensors of the cords.

Etiology.—The laryngeal muscles receive their nerve supply by means of two branches of the pneumogastric—the superior laryngeal and the recurrent laryngeal. The pneumogastric at its origin is a sensory nerve, but receives motor fibers from the spinal accessory, so that it possesses both sensory and motor functions above the point where the superior laryngeal is given off. Paralysis of the laryngeal muscles may be due, like paralysis of other muscles, to (1) disease or injury of the brain involving the cerebral portion of the nerves that supply the larynx; (2) injury or pressure of the nerves below their cerebral portion; (3) an abnormal condition of the muscles themselves, and (4) some systemic dyscrasia, like rheumatism or hysteria, because of which the muscles are unable to respond to nervous influence.

Adductor Paralysis.—Adduction of the vocal cords being performed by means of the lateral crico-arytenoid muscles and the arytenoideus muscle, paralysis of these muscles causes the cords to remain in a state of extreme abduction. This condition is in most instances due to hysteria, rheumatism involving either the muscles or the cricothyroid joint, or chronic poisoning by lead or arsenic. If bilateral paralysis exists, the vocal cords will be seen in the laryngeal mirror separated to the utmost degree (Fig. 110), and the voice will be completely lost. If paralysis of the arytenoideus muscle alone exists, which, however, is rarely the case, the anterior two-thirds of the vocal bands can be approximated; but a triangular space will be left behind the vocal processes during phonation, through which the breath escapes and renders the voice feeble, and its use in singing and speaking both fatiguing and unsatisfactory. This condition of affairs may occur during the course of either

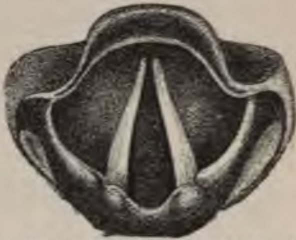


Fig. 110.—Bilateral paralysis of the adductors (crico-arytenoidei lateralis and arytenoideus). Appearance in attempted phonation (Lennox Browne).

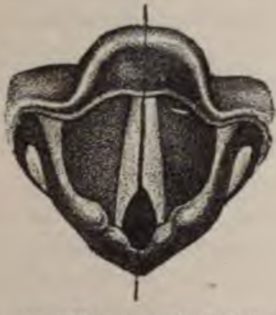


Fig. 111.—Bilateral paralysis of the arytenoideus (Lennox Browne).

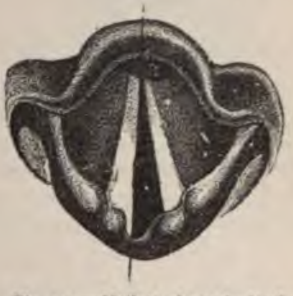


Fig. 112.—Unilateral paralysis of adductor of left cord. Appearance in attempted phonation (Lennox Browne).

acute or chronic laryngitis from extension of the inflammation to the arytenoideus muscle (Fig. 111).

In unilateral adductor paralysis only one cord is seen in extreme abduction during phonation, and the opposite cord will be observed to pass beyond the median line, so as to approach as near as possible to its motionless companion (Fig. 112). Although aphonia exists, the whispered words are usually perfectly comprehensible.

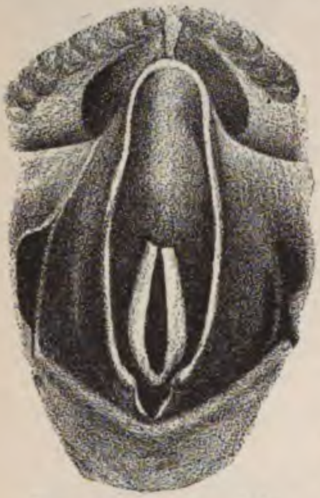


Fig. 113.—Appearance of the normal larynx after death, showing the "cadaveric position" of the vocal cords. This is also their position in quiet breathing (Lennox Browne).

Abductor Paralysis.—Abduction of the vocal cords is accomplished solely by means of the crico-arytenoid muscle, and hence the complete paralysis of both of them will prevent separation of the cords, and almost completely prevent the entrance of air into the lungs; a mere slit posteriorly, which represents the action of the arytenoideus, being the extent of the available breathing space. During expiration, however, the vocal cords are forced apart by the ascending air-current impinging upon their under surfaces, which curve upward from the sides of the larynx. The voice is unimpaired in this affection, but where complete paralysis of the abductors exists it may be necessary to perform tracheotomy to prevent suffocation occurring as the result of slight inflammatory swelling of the mucous membrane of the larynx as the result of a cold. Spasmodic abductor paralysis, or "laryngeal crisis," may occur as a complication of locomotor ataxia. Late in the disease one cord, generally the left, is often fixed in a hyperadducted position. This is in accordance with *Semon's law*, that in all progressive lesions of the centers or the trunks of motor laryngeal nerves the abductors are more frequently affected than the adductors. Paralysis of the abductors may result from a tumor in the brain involving the origin of both pneumogastrics and spinal accessory nerves. In such cases the abductors of the larynx are first paralyzed, but as the tumor increases in size paralysis of all the muscles of the larynx results, the cords assuming the "cadaveric position" (Fig. 113). Paralysis of both posterior crico-arytenoid muscles may result also by pressure upon the recurrent laryngeal nerves by an aneurysm, a goiter, or carcinoma of the esophagus, or the lesion may be located in the muscles themselves. When unilateral paralysis only is present, the affected cord will be seen to remain in the median line, even during forced inspiration, but subjective symptoms will be so slight as to hardly attract attention. The voice will be perfect and the breathing space ample, except during violent exercise (Figs. 114, 115).

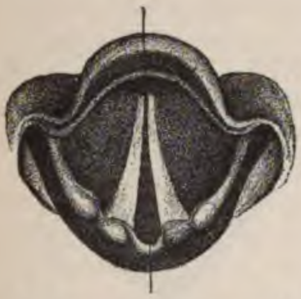


Fig. 114.—Bilateral paralysis of the abductors (crico-arytenoidei postici). Appearance with deep inspiratory effort (Lennox Browne).

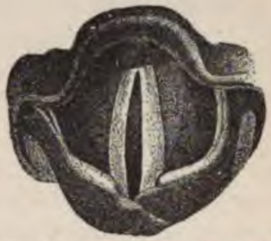


Fig. 115.—Unilateral paralysis of the left abductor. Appearance in phonation. The affected cord is seen to be in the cadaveric position, while the other is advanced beyond the median line (Lennox Browne).

Two forms of *paralysis of the tensors of the* vocal cords are met with, one due to paralysis of the cricothyroid muscle which is rare, and the other one to paralysis of the thyro-arytenoids, which is not uncommon. Paralysis of the former muscle causes the edges of the cords to assume a wavy line, touching each other at irregular intervals during phonation (Fig. 116), while the voice is coarse and remains always at the same pitch. The upper surface of the cords appears convex during expiration and concave during inspiration. When the thyro-arytenoids are paralyzed, the cords assume a slightly curved appearance when an attempt is made to bring them together during phonation, and a slight space remains between their centers (Fig. 117). The voice is husky, high pitched, and weak, the air escaping through the elliptic space between the cords, necessitating great effort on the part of the patient in order to speak.

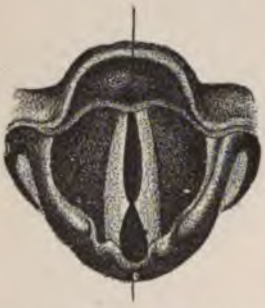


Fig. 116.—Bilateral paralysis of the thyro-arytenoidei and of the arytenoideus (Lennox Browne).

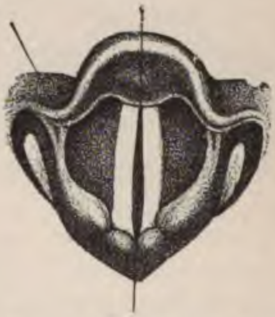


Fig. 117.—Bilateral paralysis of the sphincter of the glottis (thyro-arytenoidei) (Lennox Browne).

Treatment.—The cause of the paralysis should be carefully sought and treated, the success of the measures adopted depending, of course, upon the nature of the primary ailment. In suitable cases strychnin should be administered in gradually increasing doses until the limit of toleration has been reached, and galvanism or faradism used by means of the laryngeal electrode, applied within the larynx as near as possible to the affected muscles. An ordinary sponge electrode is held by the patient or an assistant upon the skin over the larynx, while the operator guides the tip of the electrode into the larynx, watching its progress with the laryngoscope, until it is in the desired position. The finger-rest on the top of the handle of the instrument is now depressed and the current passes. Each application should last but a few seconds, and be repeated three or four times at each sitting, at intervals of one or two minutes. Electricity may be used in this manner every other day, the current used not stronger than is sufficient to secure contraction of the affected muscles. At first the mere introduction of the electrode into the larynx causes retching and gagging, and it may be necessary to apply a 10 per cent. solution of cocain to the interior of the larynx in order to anesthetize the parts sufficiently to admit of free manipulation at the first sitting. After a few trials, however, the parts become more tolerant and application can be borne, in the majority of instances, without trouble.

Diphtheria is an acute infectious disease characterized by a pseudomembrane which usually appears in the fauces, and is associated with a rapid pulse, moderate elevation of temperature, and depression.

Etiology.—Diphtheria is endemic in all large cities, especially in the more crowded localities, and from time to time becomes epidemic, spreading to the outlying districts. It is prevalent more in the spring, autumn, and winter than in the summer. The specific cause is the Klebs-Löffler bacillus. The bacillus may be present in the nose or throats of apparently healthy individuals, the so-called "carriers," who because of natural or acquired immunity are not affected by the disease.

Pathology.—The location and extent of the pseudomembrane varies in each case. It may be limited to the tonsils or it may cover the entire fauces and extend into the nares and the larynx. It sometimes extends through the eustachian tubes to the middle ear. When a diphtheric membrane is forcibly removed it invariably leaves a bleeding surface.

The bacilli are deposited in the fauces first and cause the membrane to become red, inflamed, and swollen. The poison kills the superficial layer of epithelial cells, which undergo coagulation necrosis. There is a migration of white blood-cells, which also undergo coagulation necrosis. These processes may only extend through the superficial layer of the mucous membrane, but sometimes extend deep into the tissues and produce gangrenous ulcers. The color of the pseudomembrane is gray or grayish-white at first. It sometimes becomes yellow, but more often is white and flaky, like leaf-lard; it may also assume a dirty brown color, due to hemorrhage or to the local use of iron solutions.

Postmortem, the heart and blood-vessels show degenerative changes. The heart may contain a blood-clot. The lungs frequently show evidence of fibrinous pleurisy, bronchopneumonia, or capillary bronchitis. The liver and spleen show little if any change. The kidneys frequently show cloudy swelling. Degenerative processes have also been found in the nerve-trunks.

Classification.—Diphtheria may be classified as *mild, well-marked, severe,* and *malignant.* It is sometimes so mild as to be diagnosed only by laboratory tests; sometimes so malignant as to cause death within a few hours.

When classified according to location, as *faucial, nasal,* and *laryngeal.* There nearly always is some evidence of the disease in the fauces when either nasal or laryngeal diphtheria exists.

Symptoms.—In some cases of diphtheria there are very few or no symptoms at all, except a slight indisposition on the part of the child, and the true nature of the disease may never be recognized unless by accident. The ordinary attacks of diphtheria, however, usually begin with chilly sensations up and down the spine; occasionally with a distinct chill and rarely with a convulsion. This is followed by a rise in temperature, quickened pulse, headache, pains in the limbs, coated tongue, and sometimes nausea and vomiting. Frequently there is stiffness of the muscles of the neck. Sore throat and painful deglutition may or may not be present.

The temperature rises to 101° or 103° F. by the end of the first day. The pulse is rapid and ranges between 110 and 130. The throat looks red and inflamed at first, then there is a deposit of exudate on the tonsils, as a rule, and it spreads to the adjacent mucous membrane or may limit itself to the tonsils. It is first of a gray or grayish-white color, which becomes white or a dirty yellow as it grows older. However, it is impossible to make a positive diagnosis by the unaided eye. According to the Philadelphia Board of Health, 50 per cent. of the cultures examined clinically diagnosed as diphtheria are negative, and an equal proportion of those diagnosed as "follicular tonsillitis" are positive. The glands at the angle of the jaw become swollen and sensitive. Constipation is frequently present. The urine is scanty and high colored. It may show albumin and even casts. In the ordinary cases the depression is never profound and may be absent altogether.

In favorable cases the disease reaches its height by the fifth or sixth day, but the temperature usually falls to normal on the third or fourth day. The exudate usually disappears by the tenth day and convalescence is well established. Paralysis follows but seldom in cases where the exudate is limited to the tonsils.

In severer types of the disease the initial symptoms are more pronounced. The depression is marked and comes on early. The fauces are greatly inflamed and the tonsils so swollen as to meet in the center of the pharynx. They are covered by a thick exudate, which impedes respiration and articulation. The uvula is swollen and usually covered by exudate, which extends forward to the hard palate, and may be nearly ½ inch thick at the junction of the soft and hard palate. The posterior nares are involved by extension of membrane up the posterior surface of the uvula. This often rapidly extends to the anterior nares and both nostrils may become completely plugged by the exudate. There is a serous acrid discharge from the anterior nares which excoriates the skin of the upper lip. The cervical glands are markedly enlarged and the cellular tissues swollen and edematous. The edema at times extends down upon the sternum for several inches.

The temperature is usually normal or subnormal after the second or third day. The pulse is rapid, but soon becomes irregular and intermittent. Depression is marked from the beginning. The urine is scanty and high colored. Most severe cases show albumin and casts. Vomiting is frequent. Epistaxis and hemorrhage from the fauces and buccal membrane are common. The breath is offensive. The patient rapidly grows pale and anemic. The skin on the face has a drawn and glossy appearance. The child may die in a few days, overwhelmed by the diphtheric poison, or linger for several weeks and die of toxemia or paralysis. Any case of diphtheria, however severe, may recover, or death may occur suddenly from paralysis of the heart. When recovery takes place, convalescence is usually protracted and very tedious. Paralysis, either local or general, often supervenes.

Nasal diphtheria usually occurs in conjunction with the faucial variety or it may follow it. Occasionally it occurs as a primary disease; then the symptoms are milder and the exudate is not so extensive. There is always a marked tendency to systemic infection whenever the nares are secondarily involved. Convalescence is slow and tedious in cases that recover.

Variations from the above descriptions are numerous, for no other disease presents so many phases as diphtheria.

In *laryngeal diphtheria* there are hoarseness and a high-pitched, metallic cough—the so-called croupy cough—

which comes on in paroxysms. There is a slight rise in temperature and the frequency of respiration is slightly increased. As the exudate extends, the hoarseness and aphonia increase. Finally, the respiration becomes embarrassed and stridulous. The auxiliary muscles of respiration are brought into action. There is marked retraction in the supraclavicular and suprasternal spaces; also at the substernal space and at the border of the ribs. The alæ of the nose dilate with each respiration. The inspiration is long, deep, and labored, and more difficult than expiration, which may be comparatively easy. The child is restless, clutching at the sides of the bed or anything to raise itself up. The face is pale and bathed in a profuse perspiration. The patient has a wild, hunted expression. As the obstruction increases, cyanosis appears, the extremities become purple, the lips and face of a livid hue. Sometimes during a fit of coughing membrane is expelled as a complete cast of the larynx, trachea, and sometimes even of the smaller bronchi. This, as a rule, only gives temporary relief, for the membrane quickly re-forms and all the symptoms return. Unless these cases are relieved by intubation or tracheotomy, cyanosis becomes greater until the child dies asphyxiated.

Diphtheric paralysis is a neuritis rather than a true paralysis due to the absorption of the toxalbumins of the disease, and generally is proportionate to the severity and extent of the acute condition. Rarely, marked paralysis follows mild attacks—10 to 20 per cent. of diphtheria cases are followed by paralysis—which may be either local or general. The local variety is usually noticed by the end of the first or during the second week. The most frequent paralysis is that of the palatal muscles, giving a nasal sound to the voice. Fluids are regurgitated during swallowing. Strabismus and ptosis are sometimes seen. Paralysis of accommodation is not infrequent and paralysis of the tensor tympani and stapedius occasionally occur. Facial paralysis is occasionally seen. Loss of power in the lower extremities with inability to walk is quite common.

General paralysis usually makes its appearance from the fourth to the sixth week, and all the muscles of the body may be affected except the sphincters, which are usually spared. When all the muscles of the body are affected the temperature is usually subnormal, the pulse rapid and intermittent or very slow. When paralysis is extreme the child lies perfectly quiet, unable to move, and frequently unable to swallow. There is usually associated with these conditions a low dragging cough quite characteristic.

Systemic Infection or Toxemia.—Some of the mild cases have very little constitutional disturbance. On the other hand, some patients are overwhelmed by the poison in a few days. More often toxemia comes on later, when acute symptoms have subsided and the exudate disappeared. The patient appears bright and is apparently convalescing, except that his color is noticed to be growing paler. The pallor increases daily until the pink hue disappears from the lips, lobes of the ears, the palms of the hands, and soles of the feet. Exhaustion is extreme. The temperature is usually subnormal. The pulse may be slow or very rapid. The extremities are cold. The stomach is irritable. The least food, even cracked ice, will excite vomiting. The mind remains bright and clear. Such cases usually die of toxemia and exhaustion, and follow when the local disease has been extensive and the depression well marked.

Complications.—Epistaxis is frequent when the nares are involved and, in severe cases, hemorrhage from the fauces and buccal mucous membrane. Capillary bronchitis or bronchopneumonia is quite common and frequently fatal. It occurs during the height of the disease or during convalescence. A fibrinous pleurisy is frequently seen postmortem and occurs in conjunction with bronchopneumonia. Albuminuria is present in nearly all severe cases and occasionally gives rise to alarming symptoms. Suppression of urine may follow. Otorrhea is not uncommon, and bacilli are found in the discharges for many weeks or even months after convalescence is fully established. Pericarditis and endocarditis may also occur, but are rare.

Diagnosis.—The characteristic pseudomembrane, which leaves a bleeding surface when removed, its gray or grayish-white color, its tendency to spread to adjacent mucous membrane, the swelling of the cervical glands, and the presence of the bacilli renders the diagnosis in typic cases quite easy.

Mild cases may be confounded with follicular tonsillitis. The anginose variety of scarlatina may present some difficulty, but the strawberry-tongue, continued high fever, absence of the Klebs-Löffler bacilli, and the presence of the characteristic scarlatinal rash will exclude diphtheria.

Bronchopneumonia may be mistaken for the laryngeal variety. In pneumonia the respirations are panting and rapid; in laryngeal diphtheria they are long, deep, and labored, and the stridor usually well marked. The history of a faucial or nasal diphtheria will often clear the diagnosis.

Prognosis depends upon the character of the epidemic, the type of the disease, and the age of the patient. The death-rate depends upon the number of laryngeal cases requiring operative interference. From this class alone the death-rate varies from 30 to 75 per cent. The age of the patient also influences the prognosis. Under one year of age, from 50 to 90 per cent. die; from one to five years of age, about 40 per cent.; from five to ten years, 26 per cent.; from ten to fifteen years, 12 per cent.; over fifteen years, 3 to 4 per cent.

Treatment is divided into (1) prophylactic; (2) local; (3) constitutional; (4) serum; and (5) operative.

Prophylactic treatment consists in adopting those measures that will prevent the spread of the disease. This is best obtained by placing the patient in a well-ventilated room, preferably on the top floor, and having it isolated. All bed-linen, towels, garments, and eating utensils used by the patient should be disinfected with a carbolic acid solution (5 per cent.) before leaving the room. The attendant's clothing should be changed before mingling with other people. The physician should wear a linen duster or gown when visiting the patient. After the patient has recovered the room and its contents should be disinfected thoroughly with formaldehyd gas.

Local treatment is to reduce the inflammation, prevent the spread of the exudate, and remove what has already formed.

For this purpose hydrogen peroxid, either in full strength or diluted to suit the case, is the best local application. It should be used in the form of a spray or upon a cotton swab.

Many favor astringent solutions, preferably of the iron salts; as,

℞. Acidi carbolici . . . . ♏xv;
Ferri perchloridi . . . . f℥ij;
Glycerin }
Aqua } . . . . *āā* f℥j.—M.
Sig.—To be used every hour or two by means of a swab.

The solvents—lactic acid, peptin, caroid, trypsin—have many advocates. Lennox Browne was very partial to lactic acid applied pure twice daily, and diluted to three or four times its bulk with water, applied by the attendant every two or three hours. Löffler's toluol solution gives good results in some cases, but care must be used in applying it. Applications of a solution of 12 per cent. nitrate of silver carefully to the tonsils, palate, and lateral walls of the pharynx twice or thrice a day when they are alone affected seems to check the extension of the membrane, but whatever remedy is selected, the practitioner should see that it does not increase the inflammation or else it will do more harm than good.

Constitutional Treatment.—Iron and mercury are the two drugs we have to rely upon in the treatment of this disease. They may be used alone or combined as follows:

℞. Tr. ferri chloridi.................... ℥ij;
Syr. acidi citrici
Glycerin ....āā ℥iij;
Aqua........................q. s. ad. f℥iij.—M.
Sig.—One teaspoonful every hour or two for a child four years old.

℞. Hydrarg. chlor. corros................. gr. iss;
Tr. ferri chlor....................... f℥ij;
Syr. acidi citrici
Glycerin ....āā f℥iij;
Aqua........................q. s. ad. f℥iij.—M.
Sig.—One teaspoonful every hour or two for a child four years old.

Instead of the bichlorid, calomel may be given ($\frac{1}{10}$-gr. doses every two hours).

Stimulants are indicated from the beginning; alcohol is undoubtedly the best and should be pushed to its physiologic limit in severe cases. After the exudate disappears the whisky should be gradually withdrawn and digitalis substituted. When the stomach is irritable, digitalin should be given. A child five years old can be given $\frac{1}{30}$ to $\frac{1}{15}$ gr. or more if necessary.

Strychnin is also useful, especially in the later stages. It can be given in larger doses than is ordinarily employed.

The Serum Therapy.—To obtain the best results antitoxin should be used early in the disease, and should be used in all cases of suspected diphtheria.

In mild cases 1000 units, repeated the next day, will be all that is necessary.

In severe cases it is well to begin with 2000 units as the initial dose and repeat every six, twelve, or twenty-four hours, until the symptoms begin to subside. When the disease persists it is sometimes necessary to give as high as 20,000 units in divided doses. According to Park, the amount of antitoxin in blood during the first day is ten times greater given intravenously. Antitoxin of the highest potency should always be selected, for this gives the maximum number of units and the minimum amount of serum. It should be injected under antiseptic precautions to prevent abscesses, which occur in spite of antiseptic precautions in about 1 case in 500.

Operative intervention is indicated: (1) When the patient is cyanosed, together with marked retraction of the supraclavicular, substernal, and subcostal spaces, great restlessness, cold and clammy sweats. (2) When the symptoms of obstruction in the larynx are not so marked, but are rapidly growing worse, intubation preserves the strength of the patient. (3) When the symptoms of obstruction are not progressing, but are sufficient to prevent the patient obtaining rest. (4) In severe cases of nasal and facial diphtheria which develop laryngeal symptoms intubation permits the patient to die easy.

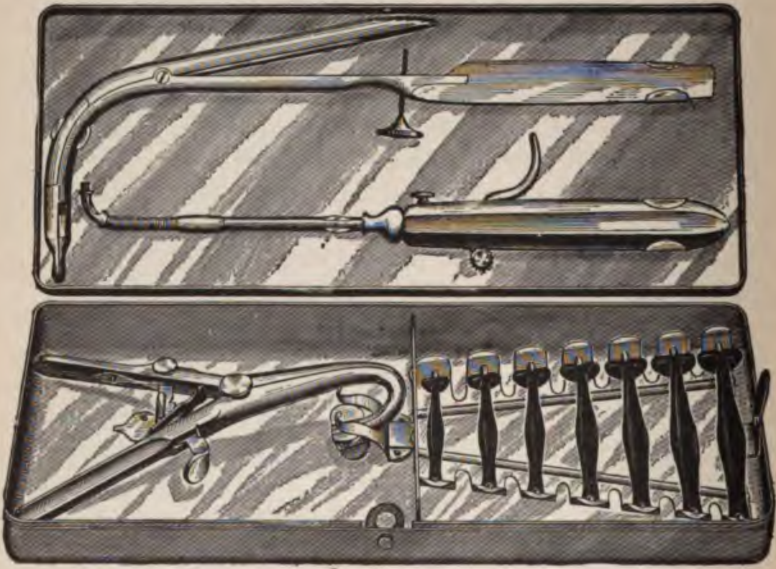


Fig. 118.—O'Dwyer's intubation set.

Intubation.—Select a tube suitable for the age of the patient, pass a strong silk thread through the eye of the tube (about 20 inches long), and tie the two ends together. Then screw the obturator on the introducer and place the tube on the obturator. Next, wrap the patient tightly in a sheet with his hands at the side to prevent them from interfering with the operator. Have the nurse sit in a chair and hold the patient upon her lap with his back to her left chest and his legs between her knees. The operator should sit in a chair facing the patient and place the gag in the left corner of the mouth. An assistant standing behind the nurse holds the gag and steadies the patient's head between his hands. Then the operator, taking the introducer in his right hand and holding the thread attached to the tube on one finger, rapidly introduces the index-finger of the left hand over the tongue until it is behind the epiglottis and

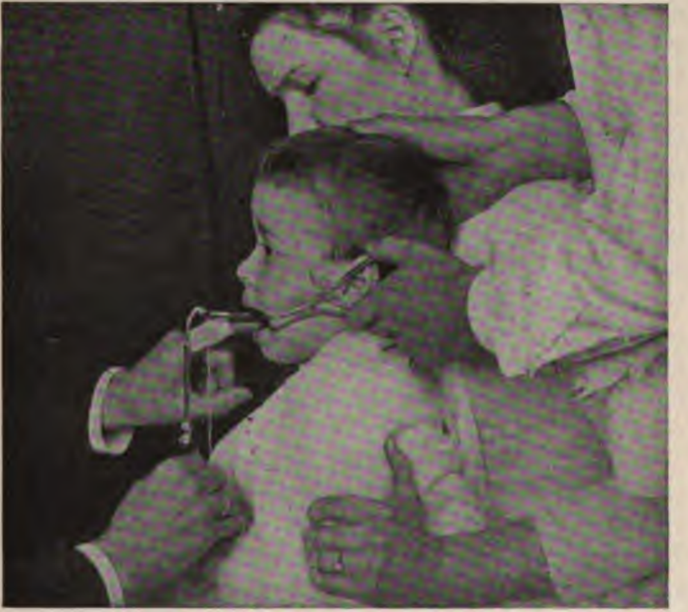


Fig. 119.—Intubation: inserting the tube (American Text-book of Diseases of Children).

the laryngeal orifice is felt. Then the tube is introduced over the tongue, being careful to keep it in the median line, until the tip of the finger at the opening of the larynx is felt (Fig. 119). Next, elevate the handle of the introducer until the tube is in a vertical position and it readily slips into the larynx. When the tube is in the larynx, press forward the button on the top of the introducer, which releases the obturator. The finger should be placed on the head of the tube until the obturator is entirely withdrawn. Next, remove the gag, but hold the end of the string until you are satisfied the tube is in the larynx and the child has obtained relief. This usually requires three or four minutes. After respirations become easy, the string should be removed or plastered on the side of the face. To remove the string the gag should be placed in the mouth and the finger should be held on the top of the tube until the thread is removed, to prevent removing the tube also.

Accident Following Intubation.—Occasionally the membrane of the larynx becomes detached and is pushed down before the tube, completely obstructing respiration. It does not often happen, but when it does the tube should be removed at once by pulling on the thread attached to the tube. This is followed by a forced expiratory effort, which, as a rule, expels the membrane. When it does not, tracheotomy should be performed immediately.

After intubation, deglutition is difficult, the patient being able to swallow only liquids and semisolids. The temperature may remain normal, but, as a rule, it rises to 102° to 103° F., and remains from 1 to 2 degrees above normal while the tube is in the larynx. When intubation gives perfect relief, the respirations are free and easy and the child is entirely comfortable. The coughing attendant upon deglutition is sufficient to keep the tube patulous; but should it become occluded or the respirations labored, the tube should be removed and cleansed. The reintroduction should depend on the character of the respirations after removal of the tube. In some cases the patient coughs up the tube when it becomes occluded, but when the tube is being constantly coughed up it indicates that it is too small and a larger size should be used. In favorable cases the time for removal of the tube will depend to a great extent upon the age of the patient. In children six or seven years old the tube may be removed in four or five days; in younger children it should remain five to seven days. When death results after intubation it is almost always due either to the extension downward of the membrane or to bronchopneumonia.

An amazing and distressing complication that sometimes arises is the inability of the patient to breathe without the tube. Children sometimes are obliged to wear the tube one hundred and ten days, being entirely well, except that they could not breathe without it. The prolonged wearing of the tube sometimes produces ulcers in the larynx, which may result in complete occlusion of that organ or so constrict the lumen that a tracheotomy is necessary.

Extubation.—The patient is prepared in the same manner as for intubation. The gag is introduced and an assistant steadies the head of the patient. The operator introduces the left index-finger in the mouth until the tube is felt behind the epiglottis. Then, with the extractor in his right hand, the beak is glided over the tongue until the tip of the finger is felt at the opening of the tube, when the handle is elevated and the beak of the extractor slips into the tube. Then, pressing the lever on the top of the handle, the blades of the beak separate and hold the tube securely until it is withdrawn.

Treatment for Intubation Patient.—When the nares are involved they should be syringed several times daily with the normal salt solution, otherwise local treatment is unnecessary and may be harmful. Steam generated in the presence of the patient is no longer considered necessary. Constitutionally, stimulants should be given as required, preference being given to alcohol and strychnin. Calomel in small doses often seems to do good in limiting the inflammation and preventing bronchopneumonia. Iron mixtures are difficult to swallow and are just as well omitted. A simple cough mixture containing ammonium carbonas and syrup of ipecac often aids in liquefying and expelling the mucus from the throat. The most important element in the treatment is the nourishment. Milk should be given freely. Broths of all kinds, beef-tea, milk-toast, and ice-cream may be given freely.

The method of *administration of food* and medicines is a much mooted question. Nursing infants take nourishment readily from the nursing bottle. In such cases lowering the head makes swallowing easier, as none of the food gets into the tube. In older patients it is best to permit them to take their food from a glass or in any way they prefer. Struggling to make the patient take it in a specified way produces exhaustion and is harmful. When children will not take food, they should be fed by introducing a soft-rubber catheter through the nose into the stomach.

Tracheotomy is indicated in the same cases as intubation and for the same reasons. In addition, it is indicated in those cases of intubation where the membrane has extended below the tube. It is also performed in cases of foreign bodies in the larynx or lower air-passages, malignant or benign growths in the larynx, edema of the larynx, fracture, gumma, tuberculosis, and spasm of the larynx.

High and Low Operations.—The high operation is an opening into the trachea through the cricothyroid membrane, including, in some instances, the cricoid cartilage and the first ring of the trachea. The incision into the trachea is *above* the thyroid isthmus. The low operation is an incision of the trachea *below* the thyroid isthmus. In this situation the opening into the trachea can be made longer, and for this and other reasons is usually the preferable operation.

Tracheotomy has been characterized as one of the most easy or one of the most difficult of surgical operations. The difficulties of the operation are enormously increased by the presence of a fat short neck and venous congestion.

Anesthetic.—In diphtheria and where there is stenosis of the larynx from any cause or great inflammation or irritability of the larynx and trachea, chloroform is the preferable anesthetic. In cases where the supply of oxygen has been deficient for some time it seldom requires more than a few whiffs of chloroform to produce unconsciousness. The chloroform, therefore, should be used with great care.

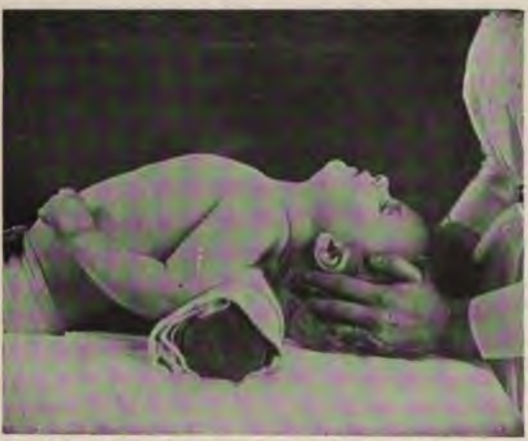


Fig. 120.—Position of patient for tracheotomy (American Text-book of Diseases of Children).

Cocain may be employed locally in adults by injecting a 1/4 of 1 per cent. solution subcutaneously along the line of incision. From 2 drams to 1/2 ounce of the solution should be necessary to produce local anesthesia.

Instruments Required.—The instruments required are a small scalpel, a bistoury, stout angular scissors, dissecting forceps, one-half dozen hemostats, grooved director, catgut ligatures, tenaculum, two blunt retractors, and tracheotomy tubes (Fig. 121).

Preparation of the Patient.—The patient is placed on the table with a small pillow, filled with sand, under his shoulders in such a manner as to bring the trachea prominently into view (Fig. 120). However, it is best not to adjust the sand-pillow until after the anesthetic has been given. The skin of the neck is scrubbed with green soap and washed with benzene and then with alcohol. Wet bichlorid towels are then placed over the chest and scalp and under the neck and shoulders.

The High Operation or Laryngotracheotomy.—For the high operation an incision is made in the median line from the top of the thyroid cartilage to the second tracheal ring. The handle of the scalpel is used to uncover the cricothyroid membrane (Fig. 92), which will be seen extending transversely across the cricothyroid artery and vein. Pushing these to one side, a transverse incision is made through the membrane and mucous membrane of the larynx. A tracheotomy tube is then inserted.

This is the simplest and easiest form of the "high operation" and is properly called *laryngotomy.* It is useful in cases of imminent suffocation, when there is not time to perform a deliberate low tracheotomy.

In cases where sufficient room is not secured by a transverse incision of the cricothyroid membrane, *laryngotracheotomy* is necessary. This consists in dividing the cricoid cartilage and the first ring of the trachea. Below this point there is danger of wounding the isthmus of the thyroid gland and causing profuse hemorrhage. The cricoid and first ring of the trachea are divided either by the scissors, one blade being inserted within the trachea through the incision in the cricothyroid membrane, or the trachea is steadied by the tenaculum and a bistoury is inserted in the wound and made to cut through the cartilage. In adults the cricoid is not infrequently partially ossified, so that a somewhat stout pair of scissors is required to sever it.

The Low Operation.—The incision should extend from the cricoid cartilage to within 1 inch of the sternum. When the skin is divided the transverse fascia will be brought into view. An opening is made in this near the middle of the wound by lifting it up with the dissecting forceps and incising it sufficiently to permit the introduction of a grooved director, which is thrust upward to the upper border of the wound. No vessel of any size being visible over the director, the fascia is incised. This is repeated in the lower half of the wound. The deep fascia uniting the two pairs of muscles, the sternohyoid and sternothyroid, is now brought into view, and is treated in the same manner, but care should be exercised in using the knife and grooved director that the cuts in the fascia extend completely to each angle of the wound to prevent it becoming funnel shaped by the time the trachea is reached.

A layer of areolar tissue and fat is now encountered containing many engorged veins. These, if possible, are pushed to one side as the operator proceeds with grooved director and knife to uncover the trachea. If it is impossible to push a vein to one side, two ligatures are passed under it and tied some distance apart, after which the vein is cut.

The wound is now widely opened by means of blunt retractors in the hands of an assistant. Its depth, especially at the lower extremity, may perhaps appall the inexperienced operator, who, however, can assure himself that he has not "missed the trachea" by tracing its course in the wound from above downward with his finger-tip. His fears will be quieted when, after carefully separating the fat and loose connective tissue in the median line, the trachea finally is uncovered, first at the upper end of the wound, where it lies most superficially. In this locality also during the operation will probably appear the isthmus of the thyroid gland. This should be pulled upward out of the way by an assistant or, should that prove impossible, the isthmus can be cut between two ligatures.

The trachea having been reached and the wound dry and free from blood, the tenaculum is inserted in it in the median line near the upper portion of the wound with the point of the tenaculum directed upward. The use of the tenaculum is necessary because of the constant movement of the trachea.

The trachea being steadied by the tenaculum, the point of a bistoury or scalpel is inserted in the trachea in such a manner as to pierce its mucous membrane, but not to cut the posterior wall of the trachea. Cutting carefully and avoiding long sweeps of the knife, which might endanger the posterior wall, three rings are cut, one after the other, with a perceptible snap, yielding in an adult an incision in the trachea about $\frac{3}{4}$ inch in length. The knife is now withdrawn and a hemostat inserted and opened, widely separating the edges of the tracheal incision.

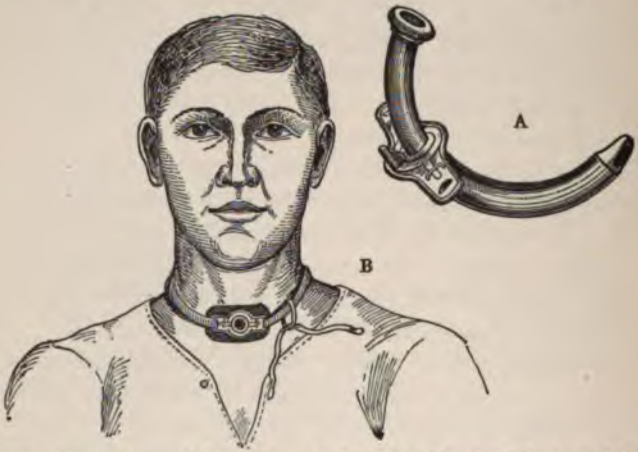


Fig. 121.—Tracheotomy: A, Tracheotomy tube with pilot; B, tracheotomy tube in position (Stoney).

The moment the trachea is opened, any blood in the wound is sucked into the trachea and immediately violently expelled together with any mucus contained in the trachea. The lungs then seem to empty themselves of air and the patient stops breathing for a period which may be an anxious one to an inexperienced operator. Finally, a long deep breath is taken, and from then on the respiration is normal. The tracheotomy tube should now be inserted and be secured by tapes (Fig. 121, B). The upper end of the wound is secured by sutures, a portion at least of the lower end being allowed to remain open for drainage. A rectangular piece of iodoform gauze sufficiently large to cover the wound is slit in such a manner that it can be inserted underneath the shield of the tube next the skin, and is held in place by the tape. A handkerchief is tied loosely about the neck in such a manner that a flap falls down over the tube and prevents the entrance of dust and other materials, and also receives secretions which are coughed out through the tube and immediately sucked back into the trachea unless absorbed by the handkerchief or gauze and removed by the attendant. In diphtheria cases the inner tube should be removed and cleansed by the nurse every two hours or oftener should the circumstances require it. When necessary the outer tube should be removed and cleansed by the surgeon. The reintroduction of the tube is facilitated by the pilot (Fig. 121, A).

After tracheotomy, during the time the patient is confined to his room, generally a week or two, the air of the room should be kept at a temperature of 80° F. and impregnated with steam from boiling water. In diphtheria cases the steam aids in keeping the secretions moist and liquid and tends to prevent the occurrence of tracheotomy, bronchitis or pneumonia.

A liquid diet should be maintained for a few days after the operation.

The wound above and below the tube usually heals rapidly, but exuberant granulations about the tube may require removal by scissors or curet.

THE EAR

ANATOMY OF THE EAR

THE ear is divided into the *external* ear, comprising the auricle or pinna and the external auditory canal; the *middle* ear, comprising the membrana tympani, cavity of the tympanum, the mastoid cells, and eustachian tube; the *internal* ear, or labyrinth, comprising the vestibule, the semicircular canals, the cochlea, and the auditory nerve (Fig. 122).

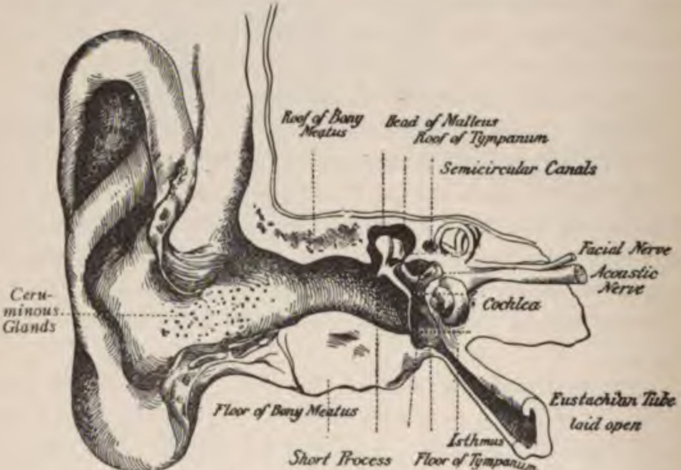


Fig. 122.—Front view of the organ of hearing (Randall).

THE EXTERNAL EAR

The Auricle or Pinna.—The auricle is an irregular mass of reticular cartilage deficient at certain parts, where it is connected by fibrous tissue and muscles. The cartilage is covered by perichondrium, outside of which is firmly adherent skin, containing sweat and sebaceous glands.

The names given to the *elevations* and *depressions* of the pinna are the helix, antihelix, fossa of the helix, fossa of the antihelix, tragus, antitragus, concha, and lobule (Fig. 123).

Muscles of the Auricle.—Those on the *anterior* surface are the tragicus, the antitragicus, the helix major, and the helix minor. Those on the *posterior* surface are the transversus auriculæ and the obliquus auriculæ. Those which connect the auricle with the side of the head and move the pinna as a whole are the attolens, attrahens, and retrahens aurem.

The *lobule* of the ear is the inferior, soft, pendulous part of the pinna, consisting of fat and connective tissue covered by skin (Fig. 123).

Vessels and Nerves.—The *arteries* are the anterior auricular branch of the temporal artery; the posterior auricular artery; a branch of the external carotid; and the auricular branch of the occipital artery. Corresponding veins accompany the arteries. The posterior auricular artery is sometimes cut by the first incision in mastoid operations and causes a somewhat profuse hemorrhage, which is readily controlled.

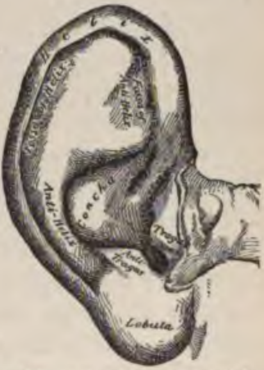


Fig. 123.—Pinna or auricle (Gray).

The *nerves* are the auricularis magnus, from the cervical plexus; posterior auricular, from the facial nerve; the auricular branch (Arnold's), from the pneumogastric; the auricular temporal, from the inferior maxillary division of the fifth nerve; and branches from the occipitalis major and minor.

The **external auditory canal** is composed of a cartilaginous and a bony portion. It is about 1¼ inches in length, the cartilaginous portion being about ½ inch in length, and forming rather less than one-half the canal, which extends from the concha to the drum-head. The external auditory meatus is lined with a continuation of the skin of the auricle, which within the canal contains hair-follicles and ceruminous glands. These glands are most numerous at the junction of the cartilaginous and bony portions. The course of the canal is generally described as that of a spiral turned anteriorly inward and downward; but in some individuals the canal is so straight that the drum-head may be inspected by simply illuminating the canal by reflected light.

It should be borne in mind that the auditory canal is narrowest near its central portion, beyond which it again expands into a sort of pouch terminating at the drum-head—an anatomic construction which adds to the difficulties of removing a foreign body should it penetrate beyond the narrowest portion of the canal.

Pressure in front of the tragus usually closes the lumen of the canal; and, owing to this valve-like arrangement, the entrance of foreign bodies into the canal is rendered more difficult. The striking feature of the cartilaginous meatus is the incisuræ santorini, which completely divide the cartilage into three half rings, united by fibro-elastic tissue.

THE MIDDLE EAR

The **membrana tympani** is a thin, elastic membrane stretched obliquely across the fundus of the external auditory canal in such a manner that its upper and posterior portion is most external. It is divided horizontally by the anterior and posterior folds into two unequal portions—the membrana flaccida or Shrapnell's membrane and the membrana tensor or membrana vibrans (Fig. 124).

Shrapnell's membrane is composed of skin from the auditory canal, and of loose cellular tissue, covered by the mucous membrane of the tympanum, on its inner surface. Bridging a notch in the bony ring, the incisura rivini, to which it is attached, it passes downward in front of the *attic* or upper chamber of the tympanum. Between Shrapnell's membrane and the neck of the malleus is a pouch or space called "Prussak's space," which sometimes becomes distended with pus during attacks of acute catarrh of the middle ear. Under such circumstances a puncture through Shrapnell's membrane, just above the short process, will evacuate the pus contained in Prussak's space and relieve the pain.

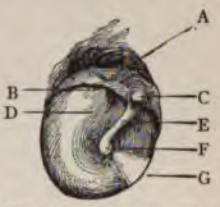


Fig. 124.—Outer surface of the right membrana tympani: *A*, Membrana flaccida or Shrapnell's membrane; *B*, posterior fold; *C*, short process; *D*, incudostapedial articulation; *E*, malleus handle; *F*, umbo; *G*, cone of light.

The *membrana vibrans* or membrana tensor is pearly white in color and is polished on its outer surface. It consists of three layers—a dermic, formed by a continuation of the skin of the auditory canal; a fibrous (membrana propria), consisting of fibers radiating from a point near the center to the circumference, and circular fibers, which are so numerous at the periphery as to form a dense ring around the attached margin of the membrana vibrans and a mucous layer continuous with the mucous membrane of the tympanum. The handle or manubrium of the malleus is fixed between the radiating and circular fibers

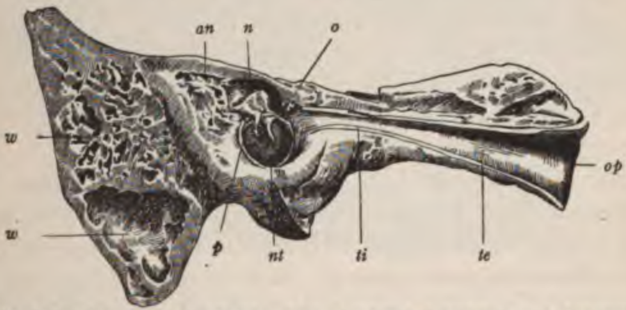


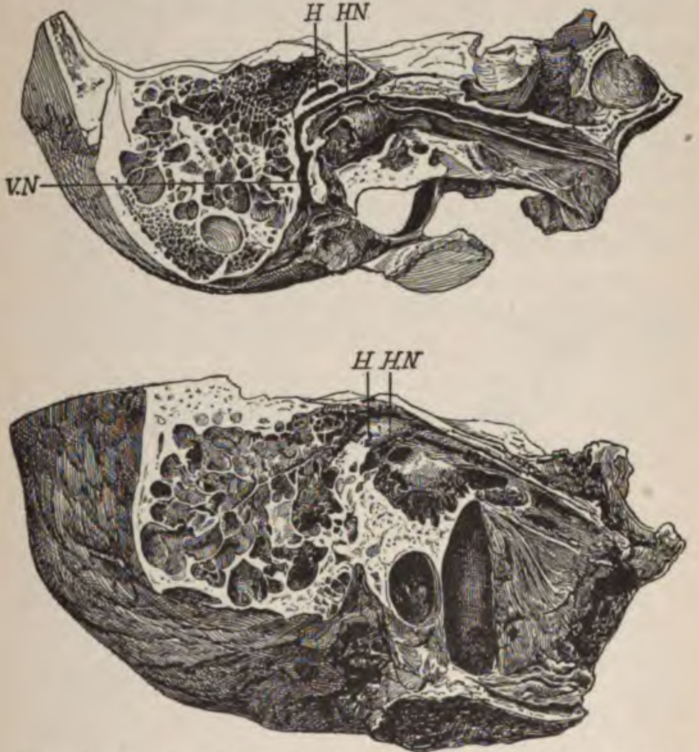
Fig. 125.—Outer half of sagittal section of entire left middle ear: *o*, Anterior and *p*, posterior, pouches of von Tröltsch; *op*, ostium pharyngeum tubæ; *te*, eustachian tube; *it*, isthmus tubæ; *mt*, membrana tympani, with the malleus and incus and the chorda tympani nerve; *n*, attic or recessus epitympanicus; *an*, mastoid antrum; *w*, *w*, mastoid cells (Politzer).

of the membrana propria. The outer surface of the drum-head faces downward, forward, and outward at an angle of 55 degrees with the axis of the auditory canal. Its outer surface is concave. From above, the malleus handle may be seen extending downward and somewhat backward from the tubercle, its short process, and ending near the center of the drum-head at a depression, the umbo. During life, when illuminated, the membrana tympani generally presents a triangular light spot or "cone of light," having its apex at the umbo and extending downward and forward to the periphery (Fig. 124). The mucous membrane of the inner surface of the drum-head is folded upon itself as it passes over the chorda tympani nerve, so that two pouches are formed, opening downward, one in front of and the other behind the manubrium (Fig. 125).

Vessels of the Membrana Tympani.—The dermoid layer is supplied with arterioles by the deep auricular branch of the internal maxillary artery; the mucous membrane, by the tympanic branches of the internal maxillary, internal carotid, and stylomastoid arteries.

Nerves of the Membrana Tympani.—To the external layer are distributed filaments from the superficial branch of the fifth nerve, while the mucous layer is supplied by the tympanic plexus.

The **cavity of the tympanum** is of irregular shape. It measures about ½ inch anteroposteriorly, ⅓ inch vertically, and ⅕ inch transversely. It is situated in the petrous portion of the temporal bone above the jugular fossa, having the carotid canal in front, the mastoid cells behind, the auditory canal externally, and the labyrinth internally. It communicates with the pharynx by means of the eustachian tube and with the mastoid antrum by means of the aditus ad antrum. The upper portion of the tympanum is called the *attic* or recessus epitympanicus. It extends *outward* over the auditory meatus, from which it is separated by a wedge-shaped mass of bone, sometimes called the scute. On the scute lie the head of the malleus and body of the incus. The handle of the malleus and long process of the incus



Figs. 126, 127.—Sections through the tympanum parallel to its inner wall; median aspect of the specimens: *H*, Horizontal semicircular canal; *H.N*, horizontal portion of aquæductus fallopii; *V.N*, vertical portion. In the upper specimen the section is somewhat more median than in the lower, in order to open the horizontal semicircular canal of the aquæductus fallopii. It will be observed that in the lower specimen, the tubercle, *H*, containing the semicircular canal is more lateral than the hard ridges of the bones below it, *H.N*, containing the facial canal. In the upper specimen the stapes is in the oval window, and the topography of the inner wall of the tympanum, the aditus, and the mastoid antrum is well shown in both specimens. (Author's specimens.)

descend through the narrow opening from the attic into the *atrium* or lower cavity of the tympanum.

The *roof* of the tympanum consists of a thin plate of bone, the *tegmen tympani*, which separates the tympanic cavity from the meninges of the brain. The *floor* of the tympanum is narrow and separates the cavity of the tympanum from the jugular fossa beneath. Nearer the inner wall is a small foramen for the passage of Jacobson's nerve. The *outer wall* consists of the membrana tympani and the bony ring into which it is inserted. In this bony ring, the annulus tympanicus, are two small orifices, the iter chordæ posterius and iter chordæ anterius, for the entrance and exit of the chorda tympani nerve. Just in front of and above this bony ring is the glaserian fissure, in which is lodged the long process of the malleus, and which also gives passage to some tympanic vessels and the anterior ligament of the malleus.

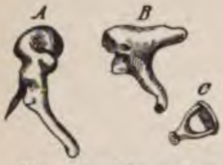


Fig. 128.—The malleus, incus, and stapes of left ear: *A*, Malleus; *B*, incus; *C*, stapes.

The inner tympanic wall (Figs. 126 and 127), which is nearly vertical, bulges outward as an eminence, the promontory corresponding to the first turn of the cochlea. Below, posteriorly, is the niche, at the bottom of which lies the fenestra rotunda or "round window," closed by the membrana tympani secundaria. This membrane is protected by the external wall of the niche, in which it so lies that it is impossible to injure it by means of a straight instrument thrust from without through the membrana tympani. Above, posteriorly, is the fenestra ovalis or "oval window," closed by the foot-plate of the stapes. Above the oval window is the eminence of the aqueductus fallopii, which transmits the facial nerve. The pyramid is a hollow conic projection containing the stapedius muscle, whose tendon escapes by an opening at its summit.

In the posterior wall above is the opening into the mastoid antrum, the *aditus ad antrum*. The anterior wall separates the cavity of the tympanum from the carotid canal, which lies immediately below and in front of it. In the upper portion of the anterior wall is the orifice of the eustachian tube. Just above is the canal for the tensor tympani muscle. The eustachian tube is separated from the canal for tensor tympani muscle by a thin bony plate, the *processus cochleariformis*.

The **ossicles** are three small bones so arranged as to form a movable chain connecting the membrana tympani with the fenestra ovalis. These three bonelets are the malleus or hammer, the incus or anvil, and the stapes or stirrup (Fig. 128).

The *malleus* is a somewhat irregularly shaped bone, consisting of an oval head, articulating with the incus; a neck, a short and long process; and a manubrium or handle, embedded in the membrana tympani. The head and neck of the malleus, which project into the tympanic cavity, are entirely free from the membrana tympani, the surface of the head, which articulates with the incus, being directed backward. The long and short processes are situated at the junction of the neck and handle of the malleus. The short process pushes the membrana tympani outward before it and is generally plainly visible during life as a tubercle at the upper extremity of the malleus handle. The long process passes forward into the glaserian fissure, with the under wall of which it unites in adult life. The malleus is held in position within the tympanum by four ligaments—the anterior, superior, external, and posterior. Of these ligaments, the anterior is by far the strongest, the posterior and external ligaments being, in a mechanical sense, but one ligament, to which Helmholtz has given the name "axial ligament of the malleus."

The *incus* is the middle one of the three ossicles, its name being derived from the shape of its upper part. This bonelet consists of a body, a short or horizontal process, and a long or descending process. The incus is attached at the extremity of its horizontal process to the posterior tympanic wall by somewhat weak ligaments (Fig. 129). The long process of the incus curves downward, and at first somewhat outward, toward the auditory meatus, its tip bending sharply inward to articulate with the head of the stapes by means of the lenticular process.

The *malleo-incudal joint* is a ginglymus or hinge-joint, like that of the knee or elbow. The ligaments of the malleus are so arranged that the bone performs the part of a lever whose fulcrum is just below the short process. The manubrium is the long arm of the lever and, consequently, all its movements are repeated in an opposite direction by the head of the malleus. Each inward movement of the membrana tympani and manubrium causes a slight outward movement of the head of the malleus. The incus being also suspended as a lever, when its upper part moves outward with the head of the malleus its long process swings inward and pushes the stapes before it, so that the foot-plate is forced into the oval window.

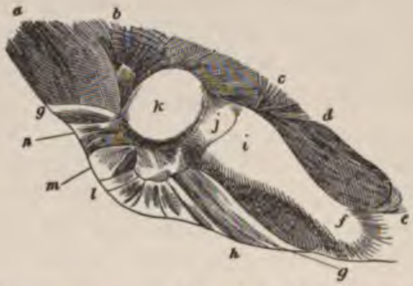


Fig. 129.—Ligamentous support of ossicles, viewed from above: *l–h*, Attachment of the ligamentum mallei externum; *k*, head of hammer; *i*, body of incus; *f*, point of its short process; *a*, entrance to the eustachian tube from the tympanum; *c*, stapes; *d*, tendon of stapedius muscle; *b*, tendon of the tensor tympani leaving the cochlear process; *g–g*, chorda tympani, marking the free edge of the folds of mucous membrane bounding the pouches; *n*, the upper tendinous fibers of the ligamentum mallei anterius, orginating above the spina tympanica major, *m*; *j*, malleo-incudal joint (Helmholtz).

The *stapes* is the smallest bone in the body. It consists of a head, articulating with the lenticular process of the incus, two branches, or crura, joining the base, which is connected by ligamentous fibers with the margin of the oval window. The stapes (Fig. 128, *C*) measures 4 mm. from its head to the foot-plate, the latter measuring $2\frac{1}{2}$ mm. in its horizontal diameter. The foot-plate of the stapes is somewhat kidney shaped. When in position its long axis is nearly horizontal, with its convex edge looking upward and its concave edge looking downward. A thin membrane, the ligamentum obturatorium stapedius, stretches across the space between the base and the crura.

Muscles of the Tympanum.—The tensor tympani originates from the under surface of the petrous bone, the cartilaginous eustachian tube, and its own osseous canal. It is inserted into the handle of the malleus near its root. Its action is to draw the membrana inward and increase its tension. The tensor tympani muscle is supplied by a nerve from the otic ganglion.

The laxator tympani major and minor have already been described as anterior and posterior ligaments of the malleus. The stapedius muscle originates from the interior of the pyramid and is inserted into the head of the stapes. Its action is to lift the anterior part of the foot-plate of the stapes out of the oval window, thus antagonizing to a certain extent the action of the tensor tympani muscle. The stapedius obtains its nerve supply by a filament of the facial nerve.

Arteries of the Tympanum.—The tympanic branch of the internal maxillary enters the glaserian fissure and is distributed to the membrana tympani. The tympanic branch of the internal carotid also supplies the membrana tympani. The stylomastoid extends from the posterior auricular to the back part of the tympanum and mastoid cells. The petrosal artery, a branch of the middle meningeal, enters the ear through the hiatus fallopii, and a branch from the ascending pharyngeal passes up the eustachian tube.

Nerves of the Tympanum.—The tympanic branch of the glossopharyngeal (Jacobson's nerve) supplies the mucous membrane of the tympanum and fenestræ. The tympanic branch of the facial nerve supplies the stapedius muscle and a branch from the otic ganglion supplies the tensor tympani muscle. The chorda tympani nerve passes across the tympanum between the handle of the malleus and the long process of the incus, without branches. It enters the tympanum by the iter chordæ posterius and emerges through the iter chordæ anterius.

The Tympanic Plexus.—Jacobson's nerve (tympanic branch of the glossopharyngeal) divides into three branches, lying in grooves upon the promontory: One joins the carotid plexus; a second, the greater superficial petrosal nerve; and a third, passing upward and forward, finally becomes the lesser superficial petrosal nerve.

The **eustachian tube,** which is about 1½ inches long, passes from the middle ear downward, forward, and inward to enter the pharynx. It affords communication between the air in the pharynx and that contained in the middle ear. The outer third consists of bone, commencing at the anterior tympanic wall, and gradually narrowing to terminate at the angle of junction of the petrous and squamous portions of the temporal bones. The inner two-thirds of the eustachian tube consists of elastic cartilage and fibrous tissue, which unite the inferior portion of a curved cartilaginous plate so as to form a tube. The mucous membrane lining the eustachian tube is a continuation of that of the pharynx and is covered with stratified ciliated epithelium. At birth the eustachian tube is nearly horizontal with its pharyngeal orifice at the level of the hard palate, until about the ninth month, when it is distinctly higher. At about this age the tube also begins to slant somewhat upward and outward. During infancy the tube is wider at its narrowest point than in the adult.

The *muscles that dilate the eustachian tube* are the levator palati muscle, which, arising from the petrous bone and cartilaginous portion of the tube, is inserted into the tissues of the soft palate, and the tensor palati, a flattened muscle, which, arising from the sphenoid bone and the cartilaginous tube, passes as a broad tendon around the hamular process to form the broad aponeurosis of the soft palate. The action of both these muscles is to dilate the tube. Some of the fibers of the tensor tympani and tensor palati are blended and an aponeurotic connection always exists along the eustachian tube, so that probably these two muscles have no action entirely independent of each other. When the soft palate is drawn upward the membrane is also retracted by the tensor tympani and the eustachian tube is at the same time dilated, so that, although a current of air enters the tympanum, it is prevented from forcing the membrane too far outward and interfering with the equilibrium of auditory tension. The tensor tympani and tensor palati receive nerve-filaments from the otic ganglion, but the levator palati is supplied by a branch from Meckel's ganglion.

The eustachian tube receives its *arterial supply* by the following arteries: The ascending pharyngeal branches from the middle meningeal and internal maxillary, and a branch from the stylomastoid artery.

Its *nerves* are, in addition to those supplying muscles of the tube, derived from the fifth and seventh pair and the glossopharyngeal.

The Mastoid Process of the Temporal Bone.—At birth the mastoid process consists of a small flattened tuberosity containing but one cell and that of considerable size—the *mastoid antrum* (Fig. 182). At puberty the mastoid process has become a distinct prominence, conic in shape, with its apex downward. The substance of the mastoid process consists of small cavities varying greatly in number, size, and shape in different individuals. Some of them communicate with each other and are lined with a continuation of the mucous membrane of the tympanum, which is here vered by squamous epithelium.

THE INTERNAL EAR OR LABYRINTH

Osseous Boundaries.—At all points the various channels and cavities of the labyrinth are deeply embedded in the petrous portion of the temporal bone. The bony labyrinth consists of a central cavity called the "vestibule," from the walls of which spring, like arches, the semicircular canals, while through the anterior wall of the vestibule a canal *leads into the* snail-shaped cavity of the cochlea (Fig. 130).

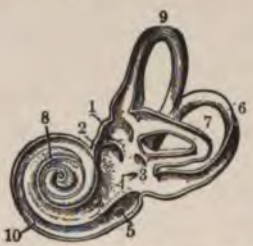


Fig. 130.—The bony labyrinth laid open by removal of lateral wall: 1, Recessus ellipticus for utricle; 2, recessus sphæricus for saccule; 3, recessus cochlea; 4, pyramus vestibuli; 5, round window; 6, posterior semicircular canal; 7, external semicircular canal; 8, cupola of the cochlea; 9, superior semicircular canal; 10, lamina spiralis ossea projecting from the modiolus into the caliber of the canal of the cochlea, and terminating in the cupola as a hook-like process called the "hamulus."

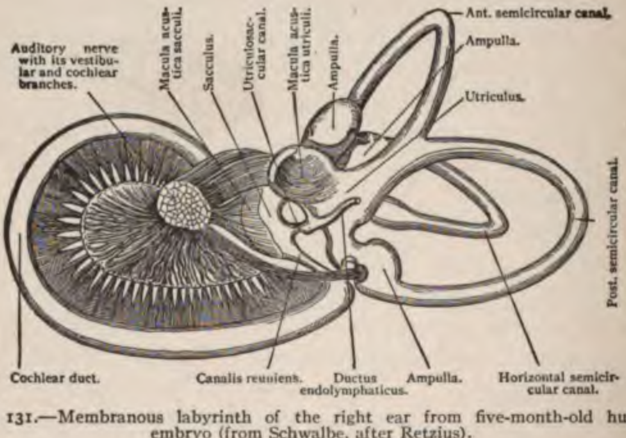


Fig. 131.—Membranous labyrinth of the right ear from five-month-old human embryo (from Schwalbe, after Retzius).

Contents of the Osseous Labyrinth.—The vestibule contains fluid and two distinct membranous sacs, the utricle and saccule (Fig. 131). The saccule communicates with one of the membranous tubes of the cochlea, the ductus cochlearis, by means of a slender membranous tube, the canalis reuniens, while the cavity of the utricle is continuous with that of the membranous semicircular canals, so that the membranous labyrinth may be said to consist of a sys-

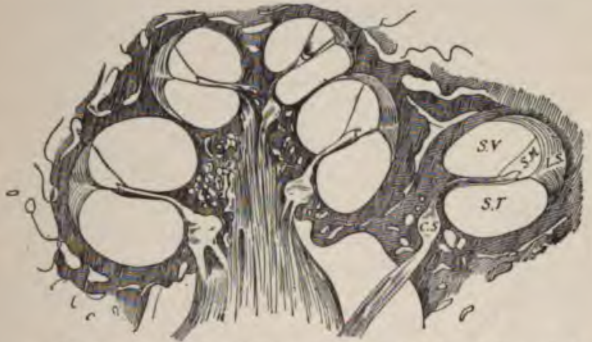


Fig. 132.—Longitudinal section of the cochlea, showing the relations of the scalæ, the ganglion spirale, etc.: *S.V*, Scala vestibuli: *S.T*, scala tympani; *S.M*, scala media; *L.S*, ligamentum spirale; *C.S*, ganglion spirale (Gray).

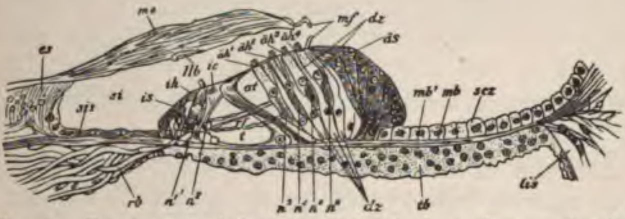


Fig. 133.—Transverse vertical section of Corti's organ of a man twenty-nine years old: *es*, Limbus laminæ spiralis; *mc*, membrana tectoria; *Hb*, Hensen's striæ; *mf*, fibers of attachment of the membrana tectoria to the zona tecta; *si*, sulcus spiralis; *sis*, epithelium of the sulcus spiralis; *is*, inner supporting cells; *ic*, inner rod cells in connection with the outer rod cells, between which is seen the tunnel (*t*) of Corti; *ih*, inner hair-cell; *äh*^{1}–*äh*^{4}, outer hair-cells; *ds*, Deiters' cells; *äs*, Hensen's supporting cells; *rb*, nerve-fibers of the ramulus basilaris; *n*^{1}–*n*^{6}, outer bundles of the spiral nerve-fibers; *rf*, radiating tunnel fibers; *at*, inner part of Nuel's space; *mb*, upper layer of the membrana basilaris; *mb*^{1}, lower layer of the membrana basilaris; *tb*, layer covering the tympanic surface of the membrana basilaris; *lis*, ligamentum spirale (Gruber, after Retzius).

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tem of cavities with membranous walls containing a fluid, the endolymph, and nearly surrounded by another fluid, the perilymph.

A diaphragm consisting partly of bone (lamina spiralis ossea) and partly of membrane (membrana basilaris) divides the cavity of the cochlea into an upper and lower space of nearly equal size (Fig. 132). The upper, the scala vestibuli, communicates with the cavity of the vestibule, and the lower, the scala tympani, ends abruptly at the round window. The upper space (scala vestibuli) is divided by a diaphragm (Reissner's membrane) placed at an angle of 45 degrees with the membrana basilaris into the scala vestibuli proper and the scala media or ductus cochlearis, which, as already described (Fig. 131), communicates with the saccule by means of the canalis reuniens. The scala media or ductus cochlearis contains endolymph and the organ of Corti (Fig. 133).

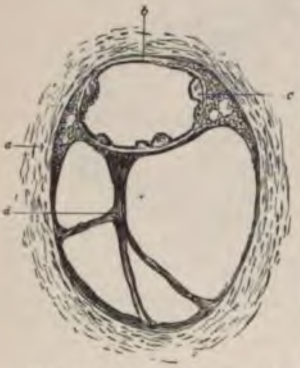

Fig. 134.—Section through the osseous and membranous semicircular canals: *a*, Osseous semicircular canal; *b*, place of attachment of the membranous semicircular canal; *c*, elevations on the inner surface of the membranous semicircular canal; *d*, vascular bands of connective tissue (Politzer).

The **organ of Corti** rests upon the membrana basilaris about midway between the lamina spiralis ossea and the outer wall of the ductus cochlearis. It extends from the vestibule to the cupola of the cochlea, and to it are distributed nerve-fibers from the cochlear branch of the auditory nerve. Corti's organ is made up of a nearly central arch, formed by the inner and outer rods or pillars of Corti (Fig. 133), the bases of which are farther apart as the organ of Corti ascends from the vestibule to the cupola. There are at the outside of the arch four rows of ciliated cells and at the inner side one row, which receive terminal filaments from the cochlear branch of the auditory nerve. The name "hearing cells" is sometimes applied to these hair-cells. There is a peculiar fenestrated membrane, the lamina reticularis, into whose net-like structure project the cilia of the outer hearing cells, which are covered and protected by a glue-like substance, the membrana tectoria. The rods of Corti have been estimated at about 10,500, while the number of hair-cells is estimated to be about 21,300.

The **membranous semicircular canals** occupy scarcely one-third of the space inside the bony canals, except at the ampullæ, where they hug the bony walls more closely. The space between the membranous canals and the bony wall is occupied by connective tissue rich in blood-vessels rather than with free fluid, as in the cochlea (Fig. 134).

The **otoliths** are granular, amorphous, sometimes crystalline particles found mostly along the walls of the utricle, saccule, and ampullæ, but also on the membranous canals, the periosteum of the osseous semicircular canals, and in the fluid of the cochlea. They consist of about 75 per cent. mineral matter, mostly carbonate of lime, and organic material resembling mucus in its physical and chemic characteristics. In some of the lower animals they are huge in size compared with those of man and assume fantastic shapes.

The **auditory nerve** originates by three fasiculæ from the superior vermiform process of the cerebellum and from the inner and outer nuclei, formed chiefly by the gray substance of the posterior pyramid and restiform body. The nerve emerges, superfically, from a groove between the olivary and restiform bodies at the lower border of the pons. At the bottom of the internal auditory canal it divides into the cochlear and vestibular divisions, both of which contain ganglion cells. The cochlear nerve divides into numerous filaments to enter the modiolus and sends branches to each of the hair-cells (Fig. 133). The vestibular nerve divides into three branches: The filaments from the upper branch enter the vestibule through the macula cribrosa at the bottom of the internal meatus, and are distributed to the utricle and the ampulla of the external and superior semicircular canals; the middle branch is distributed to the saccule, and the inferior branch passes to the ampulla of the posterior semicircular canals. (See page 546.)

Function of Vestibular Apparatus.—They are peripheral space-organs, and through centers in the brain regulate the movements of the muscles of the eye and probably all the muscles of the body for the preservation of equilibrium. The power of maintaining equilibrium is derived from the education of touch and sight and information derived from the peripheral space-organ within the ear, which informs the brain of the position of the head and regulates the movements of the muscles for the preservation of equilibrium. The otoliths, being of greater weight than the surrounding medium, probably are concerned in the production of the sensation of body weight and the direction of gravity. Hence that portion of the labyrinth containing them may be called the static labyrinth in contradistinction to the kinetic labyrinth or semicircular canals whose endolymphatic currents produce the sensation of motion and the direction of motion.

Function of the Cochlea.—The cochlea has to do with the sense of hearing. It is supposed that the individual hair-cells and rods of Corti vibrate to single tones, and that a compound sound causes the vibration of a number of hair-cells proportionate to its composite character.

TESTS FOR HEARING

Hearing is the faculty of the perception of sound.

Sound is a peculiar sensation excited in the organs of hearing by the vibratory motion of bodies, the effects of which are transmitted to the ear through an elastic medium.

Sound is a sensation and should be distinguished carefully from the vibrations that produce it; which vibrations, of course, may exist without the presence of an organized being to perceive them.

Sources of Sound.—Sound is produced by the rapid vibrations that take place in the molecules of bodies when they are disturbed by shock or by friction. When a resonant body is struck its molecules alternately approach and recede from one another with a velocity and amplitude of vibrations corresponding to the form, size, and molecular composition of the body; and this motion is transmitted by contact to any surrounding elastic medium, such as air. Sound-waves so produced are in part reflected in passing from a rarer to a denser medium, as, for example, when passing from air into water. If, however, a tense membrane, free to vibrate, is interposed between the air and any fluid or solid medium, the aërial vibrations are not reflected, but are transmitted into the more solid medium with little loss of their intensity. But for the membranes of the middle ear sound-waves transmitted from the ear to the lymph of the labyrinth would lose intensity to such a degree as to be inaudible.

Acoustics is that department of physics which treats of sounds. A rudimentary knowledge of the laws of acoustics is essential to an understanding of the physiology of the ear.

The **science of music** treats of a peculiar class of sounds and combination of sounds calculated to produce pleasurable emotions. Such sounds are distinguished from noises, which are sounds either of very short duration, like the reports of firearms, or are a mixture of many discordant sounds.

Pendulum Vibration.—If a needle be attached to one arm of a vibrating tuning-fork, and if in contact with the end of the needle a piece of smoked paper be moved at a uniform velocity, a tracing of the vibrations of the needle will be scratched upon the paper (Fig. 135). This tracing is a record of the *number* of vibrations of the fork during a given time and of the *amplitude* of the vibrations. The record is regular and uniform, and so similar to that produced by a pendulum under similar circumstances that Huxley has described this form of vibration under the name of *pendulum vibration*.

A *tone* is a sound produced by a simple pendulum vibration. It has the characteristics of quality or "timbre"; intensity, volume or loudness; and pitch (high or low tone).

The *quality* of a tone depends largely upon the *material* of the substance which produces the tone. The quality of the note emitted by striking a strip of wood is entirely different as regards its quality or "timbre" from that produced by striking a rod of metal. A note produced from an organ, a violin, or a cornet may in each case have the same pitch and volume, but will differ widely from one another as regards quality or timbre.

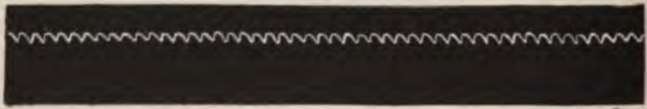

Fig. 135.—Tracing on smoked paper produced by the vibrations of a tuning-fork.

The *intensity* of a tone depends upon the force and amplitude of the vibrations which produce it. When a tuning-fork is first made to vibrate, its tone is comparatively intense or loud, because the force and amplitude of its vibrations are comparatively great, but as it continues to vibrate its tone is heard less and less distinctly, because the force and amplitude of its vibrations are becoming less and less. The pitch of the tone, however, remains the same until the fork ceases to vibrate.

The *pitch* of a tone depends upon the rapidity of the vibrations that produce it. The more rapid the vibrations, the higher the pitch. The human ear is generally able to distinguish the tone produced by a tuning-fork vibrating only 16 times during a second, and also that of a fork vibrating

38,000 times a second. The capacity, however, to distinguish sounds of very low or very high pitch varies greatly in individuals, but the ears of most persons are more sensitive to sounds of low than to those of high pitch.

The inability to hear high notes increases with age, and generally also as the result of disease of the labyrinth or acoustic nerve; and in testing the acuteness of hearing by means of tuning-forks and the Edelmann-Galton whistle it is well to bear this fact in mind. For careful tests as to the sensitiveness of the perceptive apparatus it is well for the aurist to be provided with at least five forks, the lowest (C_2) giving 32 vibrations during a second and the highest (C_4) yielding 2048 vibrations in a second. The Edelmann-Galton whistle (Fig. 136) is used also for making tests of this kind.

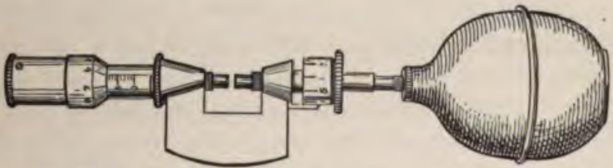

Fig. 136.—The Edelmann-Galton whistle with rubber bulb. The pipe below the opening is filled with a plunger advanced or withdrawn by a screw, each turn being shown by the scale upon the enlarged tube, and its tenths by that on the revolving collar. It gives an audible sound from 0.5 (theoretically, 84,000 v. s.) to 10 or 12 (4200 or 3500).

The *Edelmann-Galton whistle*, for testing the higher tones of the scale, consists of a metal tube so perforated as to cause a whistle when air is blown through it by means of a rubber bulb. The distal extremity is closed by a metal rod capable of being moved backward and forward within the tube by a micrometer screw. The length of the column of air within the tube beyond the perforation, and consequently the pitch of the note emitted by the whistle, are determined by the position of the rod within the tube. The micrometer screw is graduated to indicate single numbers, while on the side of the tube is a scale to show tens; so that by turning the micrometer screw the metal rod within the hollow cylinder can be placed in any position indicated by a number on the scale. The pitch of the whistle notes have a range of from about 7000 to 80,000 vibrations.

Helmholtz states that the human ear is able to distinguish as musical notes tones lying between 16 and 38,000 vibrations per second, or a range of about 11 octaves, but that the lowest note used in orchestral music is E-^{2} or one of 40 vibrations per second. In pianos the lowest note in general use is C-^{2}, 32 vibrations per second; and the highest, 7 octaves above it, is c^{5}, 4096 vibrations during a second.

Harmony.—If the rates of vibration in a second of two notes simultaneously produced stand to each other in the ratio of simple multiples, so that while the low note makes 1 vibration the high note makes 2, 3, 4, etc., the notes are said to be in harmony or concord, as the result is consonance. These are the ratios of the human voice in ordinary speaking or singing, and, according to Wolf, speech has a compass of 5 octaves, from c to c^{5}. The simplest ratio is $\frac{2}{1}$, and to this the name *octave* is given. In this case the higher note has double the number of vibrations of the lower. The ratio of the notes in the diatomic major scale is as follows:

C	D	E	F	G	A	B	C
1	$\frac{9}{8}$	$\frac{5}{4}$	$\frac{4}{3}$	$\frac{3}{2}$	$\frac{5}{3}$	$\frac{15}{8}$	$\frac{2}{1}$

The *tuning-fork* used to test the hearing should be large enough to secure sufficient intensity or loudness of tone. It is desirable to have the tuning-fork provided with movable clamps, so as to deaden overtones. While it is more convenient, as stated, for the aurist to be provided with at least five or more forks of different pitch, yet one sounding the note C (256 vibrations per second) is the most useful for ordinary clinical investigations. It should be of sufficient size to vibrate for three-fourths of a minute without great loss of intensity. It is convenient to have at hand a small tuning-fork emitting a tone of feeble intensity in order to confine the sound to one ear; because when a very heavy tuning-fork is employed in examining patients whose hearing is greatly impaired only in one ear, it is impossible to be certain that the sound of a large fork is not heard by the ear in which the hearing is better.

When it is necessary to be certain that no sound is heard by the ear not being examined, a noise apparatus should be connected with it in such a manner that other sounds cannot be heard by it.

Weber's Test.—Any obstruction to the exit of sound-waves from the middle ear when a tuning-fork is vibrating with its handle in contact with the teeth or at a point upon the cranium midway between each ear, will cause the sound of the fork to be heard most distinctly in the obstructed ear. The cause of the obstruction may be impacted cerumen in the external auditory meatus, occlusion of the eustachian tube, mucus within the tympanum, or thickening of the membrana tympani as the result of catarrh of the middle ear. Hence, if a patient is deaf in only one ear from any of these causes a vibrating tuning-fork, with its handle in contact with the teeth or on a point on the cranium midway between the ears, will be heard by him *better in the deaf ear*. If, however, the hardness of hearing is due to impairment of the labyrinth or the auditory nerve, the note of the tuning-fork will be heard *less distinctly in the deaf ear*. Weber's test is most reliable in cases of unilateral tympanic disease, less so in labyrinthine disease and in bilateral chronic middle-ear catarrh.

In practising Weber's method of examining the hearing the observer should bear in mind that the answers of some patients are largely determined by their imagination, and that they will say at first that they hear the sound of the fork most distinctly in that ear in which the hearing is better simply because *they think they should do so*. The test should be repeated sufficiently often to convince the observer that his patient's answers are reliable. It will, in all instances, be judicious to request the patient, while the fork is still vibrating upon the cranium, to close first one ear and then the other with a finger, and only after this has been done to ask him in which ear he now hears the sound of the fork most distinctly.

Rinné's Test.—Rinné observed that when a vibrating tuning-fork, with its handle in contact with the tissues over the mastoid process, ceased to be heard, the sound of the fork reappeared if it was held in front of the ear; the C fork being heard about twice as long. *Aërial conduction is superior to tissue conduction in individuals with normal ears.* If the tuning-fork is heard best by aërial conduction, the fact may be noted as Rinné+; or Rinné− if the contrary is the case; or, to be more exact, the number of seconds that the tuning-fork is heard upon the mastoid and in front of the auditory meatus may be given in the form of a fraction, the numerator of which will be less than the denominator if Rinné's method yields a positive result, and the contrary will be the case if Rinné's method gives a negative result. Thus, if a note of a C tuning-fork whose handle is in contact with the mastoid process is heard for twenty seconds, and for fifty seconds when its tines are held close to the external auditory meatus, the fact may be noted thus: Rinné $+\frac{20}{50}$. If, however, the fork is heard for thirty seconds when its handle is in contact with the tissues over the mastoid process, and only ten seconds when its prongs are held close to the meatus, the fact should be noted as Rinné $-\frac{30}{10}$ (R. $-\frac{30}{10}$). In the first instance any hardness of hearing is due to impairment of the nervous part of the ear; in the latter case it is due to the result of disease or to imperfection of the external or middle ear, or both.

It is a well-known fact that any rigidity of the conducting apparatus so alters the relation of tissue to aërial conduction that the former finally exceeds the latter. This change begins with the low notes. If Rinné's method be employed on a patient in whom there is only a slight impairment of the patency of the eustachian tubes, with congestion of the mucous membrane of the tympanum, the result will be negative with forks emitting a very low-pitched note and positive for that of a higher pitch. That is, the sound of the fork of low pitch will be heard louder and longer when its handle is firmly pressed upon the mastoid process than when the tines of the fork are held in front of the meatus. This, however, will not be the case if a fork emitting a high-pitched tone be employed. In conditions in which there is great rigidity of the transmitting apparatus of the ear, the receptive apparatus remaining healthy, Rinné's test will yield a negative result with forks of high as well as low pitch. Generally under such circumstances tissue conduction will be apparently increased; that is, a tuning-fork with its handle pressed upon the tissues over the mastoid will be heard louder and longer than normal. When, instead of this being the case, tissue conduction as well as aërial conduction is decreased, impairment of the functions of the internal ear should be suspected, although it should be borne in mind, when testing the hearing of patients past middle life, that tissue conduction of sound is always decreased as the result of senility, and sometimes as the result of other causes besides disease of the internal ear. It also should be borne in mind that in unilateral nerve deafness Rinné's test is frequently *negative* because the sound of the fork by tissue conduction is transmitted from the mastoid of the diseased ear to the normal as well as the diseased ear unless a noise apparatus is used. The test is only reliable when hearing for whispers is reduced to 1 meter, and the more profound the deafness, the more reliable the test. It cannot be depended upon in old age.

In any case, however, in which the acuteness of hearing is reduced to the perception of words spoken in a loud voice close to the ear, if tissue conduction is greater than aërial conduction only for forks of low pitch (C_1 to c), while those of high pitch (c_3, c_4) are heard very imperfectly if at all, either by aërial or tissue conduction, the receptive apparatus as well as the middle ear is impaired.

In such cases, should the tension of the structures of the middle ear be removed, it will not result in a great improvement in the patient's hearing. In cases where middle-ear deafness can be excluded, defective hearing for high tones is suggestive of labyrinthine disease for low tones of disease of the central nervous system; for the middle notes of the scale, of disease of the auditory nerve trunk.

Schwabach's Test.—This test consists in comparing the number of seconds a fork is heard on the mastoid and at the meatus in a normal ear with the time the fork is heard in these positions by the ear being examined. The difference in time a patient hears a fork vibrating on his mastoid and the physician hears it is ascertained by the oscultation tube (Fig. 137), which connects the meati of observer and patient so that both hear the sound of the fork vibrating on the patient's mastoid.

Gelle's Test (*Pressions Centripetes*).—If the air within the auditory canal be compressed by means of Siegle's speculum or any suitable instrument, a normal ear will hear the sound of a tuning-fork vibrating on the cranial bones with diminished intensity. This phenomenon is due to increased labyrinthine pressure, because when the air within the auditory canal is cóndensed the chain of bonelets with the footplate of the stapes is pressed inward. If ankylosis of the stapes exists or if there is great immobility of the ossicles the tone of the tuning-fork will remain unchanged during the test, while if the labyrinth is diseased and the stapes is movable the application of Gelle's test will produce vertigo. The test is of value in the diagnosis of otosclerosis.

Bing's Test.—If a tuning-fork is vibrated upon the mastoid process of a normal ear after its sound is no longer audible it can be made to reappear if the meatus is tightly closed with the moistened finger. In cases of severe deafness, according to Bing, if this test yields a negative result, the hardness of hearing is due to a middle-ear affection, while if the result of the test is positive, the deafness is the consequence of a labyrinthine affection.

Dr. Bing uses also, as an aid to diagnosis, what he terms the "entotic" use of the speaking-trumpet, which consists in speaking into the speaking-tube connected by means of an air-tight joint with a catheter introduced into the mouth of the eustachian tube. If the voice is heard better by this method than when the speaking-tube is used in the external meatus, there is hindrance to sound conduction at the malleus or the incus, and the *foot-plate of the stapes is freely movable in the oval window.*

Politzer's Test.—If the sound of a tuning-fork vibrating before the nostrils is heard louder during the act of swallowing it indicates that the eustachian tubes are functionating.

To **test the hearing by a watch** the patient should be seated with his face so covered by a napkin or towel that it is impossible for him to see the watch, because many patients imagine that they hear a watch which they see held close to their ear. It is well also to request the patient to close firmly with his forefinger the ear that is not being tested. The aurist should hold the watch in his hand with its case open close to the patient's ear until the latter hears it distinctly, then move his hand to a considerable distance and slowly bring the watch toward the ear being examined, observing the exact distance the watch is when *first* heard. The result of the examination may be expressed by a fraction, the numerator of which is the distance at which the patient hears the watch and the denominator the distance at which the watch can be heard by a normal ear. For example, if the watch used in making the test is heard by a normal ear at 40 inches, and the patient hears it only at 15 inches, the fact may be recorded thus: Hearing for watch is $\frac{15}{40}$ (H. W. = $\frac{15}{40}$). If the watch is heard only on contact with the auricle, the record should read, Hearing for watch is $\frac{\text{contact}}{40}$; or, if it is only heard by exerting considerable pressure with it upon the auricle, Hearing for watch is $\frac{\text{pressure}}{40}$.

The room in which the hearing is being tested by the watch should be as free from noise as possible, and the watch should invariably be made to approach the patient's ear from a distance, as directed above, and the point be noted at which it is *first heard*, because, while the patient still hears the watch if it is slowly carried away from his ear, it will be found that he will continue to hear it at a much greater distance than that at which he would *first hear* it if it were made to approach his ear from a distance. The hearing may be tested in a similar manner by means of the acoumeter, an instrument devised by Politzer. The acoumeter gives the note c with about the same loudness as the sound of a loud-ticking watch. A *stop* watch is more convenient than an ordinary watch for testing the hearing, especially in children.

The C tuning-fork also may be used for testing the hearing, and when there is considerable noise, as in a dispensary, is more reliable than either the watch or acoumeter. The fork is placed at right angles to the operator's thigh with its handle in contact with the tissues and the tines allowed to fall forward by gravity until one of them strikes the muscles in the neighborhood of the knee. Whenever the fork is set in vibration by this method the intensity of its tone will be the same, and hence the distance in inches at which it is heard by a patient can be compared with the distance at which it is heard by a normal ear, and expressed in the form of a fraction, for example, $\frac{6}{18}$.

In **testing the hearing by the voice** the patient should close the ear not being tested firmly with his forefinger, and either close his eyes or look in such a direction that it will be impossible to see the motion of the aurist's lips; the distance in feet should then be observed at which words are heard when spoken in a whisper, ordinary conversational tone, or a loud voice if the patient be very deaf. In making this test of the hearing power it is best, in most instances, to employ single words of only one syllable. The result of the examination may be noted as a fraction, the numerator of which is the distance in feet at which the patient hears the words, and the denominator the distance in feet at which a normal ear can hear the same words. For example, if the patient hears whispered words 3 feet from his ear, and should hear them at 20 feet, the fact may be recorded thus: Whisper $\frac{3}{20}$.

The words used in making the test are by no means a matter of indifference, as some words are higher pitched than others. S is the highest pitched letter in the musical scale and R the lowest. High-pitched words are: six, scissors, sister; low pitched, rural, rude, horror; medium pitched, table, baby, Mary.

In the voice test as ordinarily made the examiner places himself 20 feet away from the patient and whispers numerals slowly one after the other, the patient repeating them after him. If the patient is unable to hear the numerals the examiner advances slowly toward him, a foot or two at a time, until the numerals are heard and correctly repeated by the patient. The whisper employed is the so-called "stage whisper," made by expiring all the air possible from the chest and then whispering with the residual air. Because of the greater impairment of hearing for low-pitched sounds in middle-ear deafness, numerals which have the S sound, like 6 and 7, are often heard at a slightly greater distance or more clearly than the others.

PATHOLOGIC CONDITIONS OF NOSE AND PHARYNX CAUSING DISEASE OF EAR

Anatomically the eustachian tube, tympanum, and mastoid cells are more closely related to the nasopharynx than the internal ear, being an extension from the oronasal cavity, an accessory sinus, as a matter of fact, of the nose;

and only incidentally related to the ear proper, which is developed from a separate otocyst. The arterial, venous, and lymphatic circulation of the middle ear is closely related to that of the nose and pharynx; and hence its pathology at least has its origin in most cases from a nasal or pharyngeal disease.

As the result of chronic nasopharyngeal catarrh the eustachian tubes and middle ear become affected in a proportion of cases. Especially if the catarrh be of the hypertrophic variety, so that nasal respiration is interfered with by the presence of anterior and posterior hypertrophies, ecchondroses or exostoses from the septum, etc., disease of the eustachian tubes may result. The same is true of a deflection of the septum sufficiently great to cause marked obstruction of one nostril. In many instances catarrh of the eustachian tube and middle ear is the result of the extension by continuity of surface of a similar affection of the nasopharynx. However, when one or both nasal chambers are obstructed other causes probably bring about the same result. Posterior to the obstruction, in nearly all cases of nasal stenosis, a partial vacuum is formed during inspiration; as the result the nasal mucous membrane is constantly engorged with blood in this locality. This condition may extend back far enough to involve the pharyngeal mouth of the eustachian tube. Probably most cases of one-sided deafness on the same side as an obstructed nostril may be explained in this manner. The hearing in such cases frequently improves rapidly after the removal of the nasal stenosis, but a posterior hypertrophy may be so situated as to produce venous stasis in that locality. By far the commonest cause of eustachian salpingitis, in children at least, is hypertrophy of the pharyngeal tonsil. When the adenoid overgrowth is situated so as to interfere with the return of blood from the mucous membrane of the eustachian tubes, stenosis results because of engorgement and inflammation, and the hearing deteriorates more and more as the result of each succeeding attack of coryza. Under such circumstances, if the hypertrophy has not existed too long, a complete restoration of the hearing may be expected to follow the removal of a portion of the hypertrophied gland. Occasionally cicatricial bands in Rosenmüller's fossa present the proper movement of the tube mouths, and when present should be broken down. However, it must not be supposed that by removing the nasal disease which produced the aural affection a complete restoration of the hearing will result in every instance. In most cases of this kind careful treatment of the tubal or middle-ear disease is *absolutely necessary*.

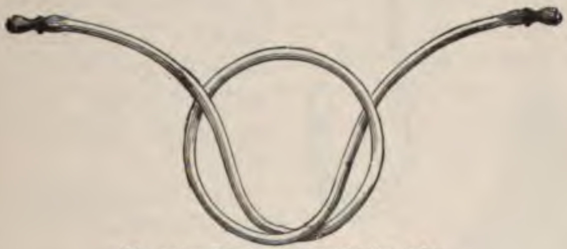

Fig. 137.—Toynbee's auscultation-tube.

The pharyngeal mouths of the eustachian tubes, bordered by their cartilaginous lips, appear as crater-shaped elevations in front of Rosenmüller's fossa. The mucous membrane at the entrance of the tube is, in the normal state, paler than that in its vicinity, which is of a deep red color over the cartilaginous lips, which may be congested, anemic, hypertrophied, with or without lymphoid excrescences, atrophic, with or without mucus or crusts protruding from them, and perhaps overhung by adenoid tissue from the fossa of Rosenmüller. The tube mouths may be inspected either by posterior rhinoscopy or with the nasopharyngoscope, by means of which not only the pathologic condition of the tubal mucous membrane but also the movements of the tube mouths can be seen.

Patency of Eustachian Tubes.—The methods most commonly used to test the patency of the eustachian tubes and introduce air into the middle ear are Valsalva's, Politzer's, and catheterization of the eustachian tubes.

Valsalva's method consists in a forced expiration, the mouth and nose being closed. In this method air is forced from the pharynx through the eustachian tubes into the middle ear. If the aurist examines the membrana tympani while the patient inflates the middle ear by Valsalva's method the drum-head will be observed to move outward, and in most instances it will become slightly congested. If an aural stethoscope be used a slight noise will be heard as the air enters the patient's middle ear.

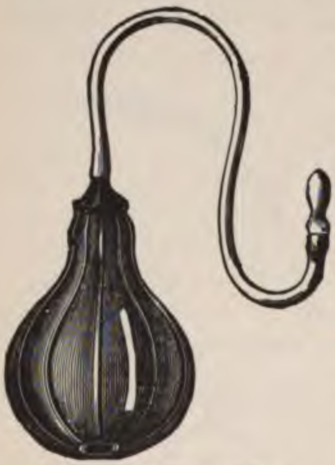
Fig. 138.—Politzer's air-bag.

The *aural stethoscope* or *auscultation-tube* consists of about 3 feet of thin rubber tubing, into the ends of which appropriate ear-pieces are inserted. One ear-piece should be of white bone for the aurist's own ear, and the other end of hard rubber, to be inserted into the auditory canal of his patient's ear.

In *Politzer's method* the patient is directed to hold a small quantity of water in his mouth until he is told to swallow. The aurist then takes the nose-piece of Politzer's air-bag (Fig. 138) between his thumb and finger and inserts it into one of the patient's nostrils, and closes both nostrils firmly about the nose-piece by pressure with his middle finger and forefinger. The patient is then told to swallow; as the patient's larynx is seen to rise at the commencement of the act of swallowing the aurist quickly compresses the air-bag held in his right hand, thus forcing air through the nose and eustachian tubes into the middle ear. If the auscultation-tube is used during this procedure the air will be heard to enter the middle ear with the same audible *click* observed when Valsalva's method of inflating the middle ear is employed.

During the act of swallowing the soft palate rises, thus cutting off all communication between the posterior nasal chamber and the mouth, and at the same time the eustachian tubes are rendered more patulous by the action of the levator palati and other muscles, so that air forced into the nose by Politzer's method, having no other way of exit, readily finds its way into the middle ear through the tubes. The same thing may be accomplished with greater convenience by requesting the patient to "puff out his cheeks" and compressing the air-bag while the mouth is thus inflated with air. Pronouncing certain syllables, like the words *hick*, *hack*, *hock*, also causes an elevation of the soft palate and a dilatation of the eustachian tubes, so that the middle ear can readily be inflated by means of Politzer's air-bag. The middle ear of young children is usually more easily inflated by means of Politzer's air-bag than that of adults, while in the case of infants air readily enters the middle ear if Politzer's air-bag be used while the child is crying.

No more force should ever be employed in compressing the rubber bag than is absolutely necessary to force air into the middle ear, and it is far better for the aurist to make several unsuccessful efforts to accomplish this purpose than to drive air into the middle ear with sufficient force to cause pain.

It is probably impossible to rupture a *normal* membrana tympani with Politzer's air-bag, but atrophied or diseased drum-membranes have been ruptured by the incautious use of this instrument.

The *eustachian catheter* is a tube of metal curved at its distal extremity, as shown in Fig. 139. The proximal end of the instrument is so constructed that the nozzle of Politzer's air-bag will fit *loosely* into it, and it is provided with a ring or mark of some sort by which the aurist is informed of the position of the beak of the instrument when it has been inserted in the nose. At least three sizes of this catheter should be in possession of the aurist—respectively 1, 2, and 3 millimeters in diameter. The best catheters are made of pure or, as it sometimes is called, "virgin" (in contradistinction to "coin") silver, which insures a certain degree of flexibility. The cheap brass, nickel, or silver-plated instruments are clumsy, and are so hard, brittle, and inflexible that the curve of the beak cannot be slightly changed readily, as in the case of the softer pure silver instruments. The distal extremity should be slightly knobbed, smooth, and round. What is known as Hartmann's catheter is probably the best model (Fig. 139).

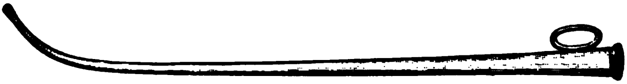

Fig. 139.—Hartmann's silver eustachian catheter.

Introduction of the Beak of the Catheter into the Eustachian Tube.—The operator should first inspect the anterior narium and note the position, size, and shape of any obstruction, such as a septal exostosis, which will interfere with the passage of the catheter. The operator should hold the proximal extremity of the catheter between the thumb and fingers of his right hand, somewhat in the manner of a penholder, and lift up the tip of the patient's nose with the thumb of his left hand. The beak or distal extremity of the catheter is then inserted within the nares and is made to rest upon the floor of the nose, while the proximal end of the instrument is elevated until it is parallel with the floor of the nose.

Still keeping the beak of the instrument in contact with the floor of the nose, the catheter is pushed gently inward until the beak of the instrument is felt to be in contact with the posterior wall of the pharynx. At this stage the operator has the choice of the three methods of procedure in common use.

Probably the one most frequently employed is that of Löwenburg, who directs that when the beak of the instrument is felt to be in contact with the pharyngeal wall the catheter should be rotated medianly through an angle of 45 degrees, and drawn forward until the beak of the instrument is felt to touch the posterior edge of the septum, when it is rotated outward through rather more than an angle of 90 degrees, and should then be in the mouth of the eustachian tube. The operator may feel satisfied that this is the case if the beak of the catheter is found to be somewhat firmly fixed in the position it has assumed, so that it is impossible to rotate the beak of the instrument upward or carry it backward or forward without exerting considerable force.

Gruber directs that when the beak of the catheter is felt to be in contact with the pharyngeal wall it should be withdrawn until its curved portion comes into contact with the posterior margin of the hard palate. It should then be again pushed inward a distance of about ½ inch, and rotated outward toward the ear through an angle of a little more than 45 degrees, when, if these maneuvers have been successful, the beak of the instrument will be within the mouth of the eustachian tube.

When the beak of the instrument is felt to be in contact with the pharyngeal wall it may be immediately rotated outward 45 degrees, which will carry the beak of the instrument into Rosenmüller's fossa. The catheter should now be drawn gently outward until its beak is felt to slip over the posterior lip and into the mouth of the tube. An operator soon learns by the sensation imparted to his hand whether the beak of the instrument is or is not in the eustachian tube.

Obstacles to Catheterization of the Eustachian Tubes.—Deviation of the septum may render the passage of a eustachian catheter through that side of the nose impossible. Under such circumstances both eustachian tubes may be catheterized through the unoccluded nostril. To reach the tube of the opposite side it will be necessary to bend the beak of the catheter at a somewhat longer curve than that of the instrument shown in Fig. 139.

Ecchondroses or exostoses of the septum frequently interfere with the easy passage of the catheter through the inferior meatus of the nose. Under such circumstances the beak of the catheter can sometimes be passed over them and made to rest upon the floor of the nose or the soft palate behind.

In passing the catheter through the nose the instrument should be held very lightly between the thumb and finger, and a tendency to rotate on its long axis should not be resisted, because by allowing the instrument to rotate its beak will sometimes glide around an obstruction and finally find its way into the pharynx.

Another obstacle to catheterization of the eustachian tubes results from spasmodic contraction of the muscles of the palate and pharynx, which tightly grasp the beak of the instrument and interfere with its proper manipulation. Gentleness and patience on the part of the surgeon will generally overcome this difficulty. The patient should be requested to inhale deeply through his nose, to "swallow," or say "One," and thus produce a temporary relaxation of the parts, which, if repeated from time to time, will enable the surgeon to guide the beak of the catheter into the mouth of the eustachian tube.

When the beak of the catheter is felt to be within the mouth of the eustachian tube it should be held in position with the thumb and forefinger of the left hand and steadied by two fingers resting upon the patient's face (Fig. 140). The nozzle of the air-bag is then fitted *loosely* into the proximal end of the catheter and compressed with the right hand. If the *auscultation-tube* be employed at the same time, air will be heard to enter the patient's middle ear with a sound somewhat similar to that produced by inflating the middle ear by Valsalva's or Politzer's method. However, when the catheter is employed the sound seems as if produced *nearer* the surgeon's ear.

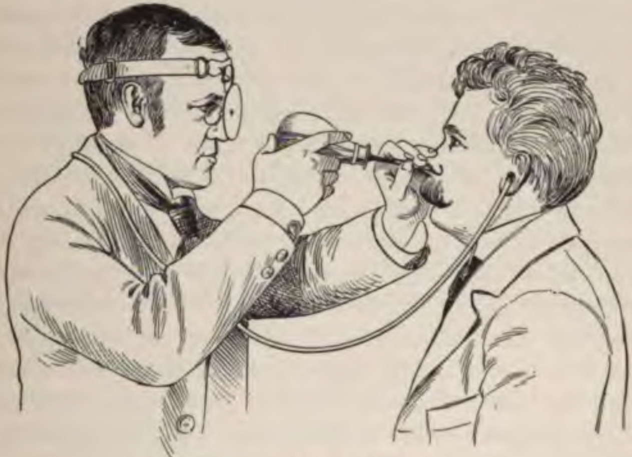

Fig. 140.—Auscultation of the ear.

The *inflation of the middle ear* by means of the eustachian catheter is not altogether devoid of risk. Deaths have been reported. The fatal results in these instances may have resulted from injection of air through a rent in the mucous membrane made by the beak of the catheter, which subsequently found its way beneath the mucous membrane to a position where the emphysema caused sufficient obstruction to respiration to occasion suffocation.

The writer saw two cases where young and inexperienced operators had injected a sufficient amount of the air contained in a Politzer bag through a eustachian catheter into the cellular tissue to cause decided swelling of the tissues of the neck. In these two cases the patients simply suffered a certain amount of discomfort for a few hours, the air in the tissues being finally absorbed.

Solutions may be sprayed through the catheter by means of an ordinary atomizer by inserting the nozzle of the atomizer into the catheter. Either the compressed-air apparatus or the hand-bulb may be used to produce the spray. Under ordinary circumstances the spray probably does not penetrate the tube further than the isthmus, except the patient be told to swallow, when the spray may be heard through the auscultation-tube to enter the tympanum, sounding not unlike drops of rain falling on a tin roof. When compressed air is used to produce the spray it should be employed gently and with due caution. The automatic cut-off should be manipulated in such a manner as to throw the spray gently and by successive puffs into the eustachian tube orifices. The drip of the solution that condenses in the catheter should, at the completion of the treatment, be blown into the eustachian tube by means of Politzer's bag.

Instead of employing an atomizer, fluid may be inserted within the catheter by an ordinary glass medicine-dropper and thrown into the tube with Politzer's bag, or fluid may be syringed through the catheter into the eustachian tube, and when the drum-head is perforated, through the eustachian tube and tympanum into the external auditory canal.

When the drum-head is intact, fluid enters a narrow eustachian tube beyond the isthmus only with great difficulty, having to compress before it the air contained in the middle ear. As soon as the pressure is relaxed the spring or rebound of the compressed air generally throws into the pharynx fluid contained in the tube. However, during the act of swallowing fluid may be made to penetrate into the cavity of the tympanum through the eustachian tube even when the drum-head is intact, the muscular action in opening and shutting the tube during swallowing doubtless playing an important rôle under such circumstances. In this manner sea-water or fresh water introduced into the pharynx while bathing sometimes reaches the tympanum and almost invariably produces an acute otitis media. The writer has observed the same thing occur during the use of the Birmingham douche or even from sniffing normal salt solution into the nose from the hollow of the hand.

The introduction of watery solutions, even of the blandest character, is not devoid of risk unless the drum-head is lacking or contains a large perforation. Bland oily fluids, on the other hand, can be sprayed or syringed into the middle ear with impunity. When the watery fluid is used to wash out the eustachian tube the operator should be careful to inflate the middle ear several times by means of Politzer's method in order to remove any excess of fluid that might otherwise remain.

Solutions of 1 or 2 drops of argyrol, 10 to 50 per cent., nitrate of silver, ½ to 1 per cent., potassium iodid, 1 per cent. (in syphilis), may safely be introduced into the mouth of the eustachian tube.

An *Allen probe* (Fig. 25), sufficiently long to extend ¼ inch beyond the catheter mouth, may be used as an applicator by wrapping a few fibers of cotton about its tip and dipping the end of the probe into the solution to be used. After the beak of the catheter is in position the cotton-tipped probe is passed through it and an application of the remedy made to the first ¼ inch of the eustachian tube, or the end of a cotton-tipped Allen probe, after being dipped into any appropriate solution, may be passed like a catheter through the nose into the nasopharynx and the cotton-tipped end inserted into the mouth of the eustachian tube.

Eustachian bougies are occasionally used for the dilation of strictures of the eustachian tube and other purposes. They are filiform in character and a number of sizes are obtainable, made of whalebone, hard rubber, celluloid, or gold, for electrolysis of stricture. They are inserted into the eustachian tube through a catheter.

Dixon has devised a set of five metal applicators with the distal bend at an angle of 45 degrees at the distance of ½ inch (No. 5) to 1½ inch (No. 1). Dilatation is made by cotton wrapped about the ends of the applicators and soaked in 5 per cent. cocain adrenalin and followed by 1 per cent. silver nitrate or argyrol.

Before attempting to pass the bougie a few drops of liquid albolene should be inserted in the catheter and blown into the eustachian tube by means of Politzer's bag. If a stricture is passed, a bougie should be allowed to remain in position for five or ten minutes. After the bougie is withdrawn the middle ear should be gently and cautiously inflated. If there be reason to suppose that during the passage of the bougie the mucous membrane has been torn, it will be safer to dispense with inflation, lest air penetrate the cellular tissue.

Electrolysis of eustachian strictures has been done by means of an insulated eustachian catheter and gold bougies. The amount of current necessary to overcome an obstruction and promote absorption of a stricture is 3 to 5 milliamperes, which should be turned on as soon as an obstruction is felt and continued for not longer than three to five minutes. The negative pole of the battery is attached to the bougie, the positive held in the patient's hand or applied to the nape of his neck. There is little pain produced by the procedure, which may be repeated at intervals of a week. Inflation should not be practised immediately after the use of the electric bougie, but the patient may return the next day to have his middle ear inflated.

DISEASES OF THE EXTERNAL EAR

Congenital Defects.—The auricle may be wanting entirely or there may be a plurality of auricles (Fig. 141). The auricle may be abnormal as regards position or shape or it may only be partially developed. Malformations of the auricle are generally associated with defects or absence of the external auditory canal (Fig. 142), and sometimes imperfect development of the deeper portions of the auditory apparatus. A congenital fistula is sometimes seen about the external ear and may communicate with the tympanic cavity (Fig. 143). Excessive development or lack of development of the external ear is due to excessive or imperfect development in the closure of the first branchial cleft

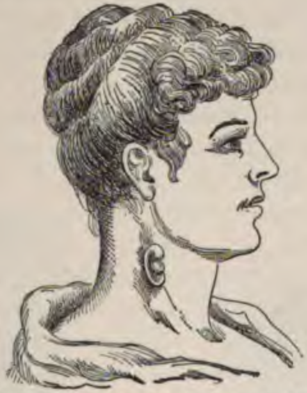

Fig. 141.—Supernumerary auricle in the neck (Lancet, 1888).

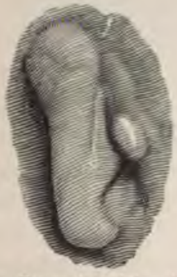

Fig. 142.—Congenital deformity of the auricle (Sexton).

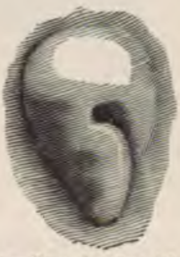

Fig. 143.—Convoluted auricle with congenital fistula (Sexton).

during embryonic life. Various operations have been devised to correct deformities of the auricle and open a way down to the tympanum in cases of stenosis of the external auditory canal. Plastic operations in this locality do well as regards the healing process. Operations for the correction of atresia or stenosis of the external auditory canal hitherto have not been successful.

Othematoma or **perichondritis** of the auricle (Fig. 144) is generally the result of direct violence—self-inflicted in the insane, among whom the disease is not uncommon. This affection is characterized by an effusion beneath the perichondrium of the auricle, causing swelling, tension, and pain in the part. The effusion may finally escape through an external opening which it has made for itself, remain as a swelling for an indefinite time, or slowly be absorbed. Even when reabsorption of the effusion does occur, considerable deformity of the auricle may result (Fig. 145).

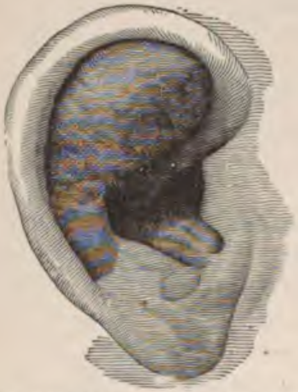

Fig. 144.—Medium othematoma of the auricle (Sexton).

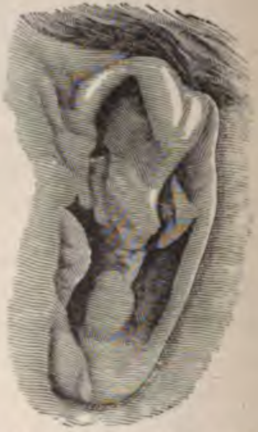

Fig. 145.—Deformity of the auricle due to othematoma (Sexton).

Treatment.—In the insane, hematoma of the auricle is best let alone unless the local inflammation is sufficiently great to indicate that infection has occurred and that the effusion has become purulent. If necessary inflammation should be combated by the application of ichthyol ointment (20 per cent.) in lanolin (adeps lanæ hydrosus), and progressive effusion by painting the affected parts with contractile collodion and the use of a pressure bandage. Absorbent cotton is placed between the auricle and the head and a pad of cotton over the auricle, and pressure maintained by means of a roller bandage over the auricle and around the head. The bandage should not be applied with sufficient firmness to cause pain or great discomfort. If, notwithstanding these measures, the collection of fluid beneath the perichondrium increases, the parts should be aspirated with antiseptic precautions—a measure that will probably need repetition from time to time. In cases where the inflammation is great and the effusion beneath the perichondrium is evidently purulent, it is best to lay the parts freely open, wash out the pus-cavity with sublimate solution, and pack with iodoform gauze. The incision should be sufficiently free to permit of easy dressing and the ready removal of sloughing cartilage as soon as separated from the living tissue. Fortunately the number of cases where the injury to the auricle is sufficiently severe to cause sloughing of even a small portion of the cartilage are comparatively few.

Chronic perichondritis is a chronic inflammation of the cartilage of the auricle observed in boxers and others whose ears are constantly subjected to irritation or slight traumatism.

Treatment consists in gentle massage and applications of 20 per cent. ichthyol ointment at bedtime, with the avoidance of the cause of the irritation.

Incised and **punctured wounds,** after thorough cleansing, should be sutured in such a manner as to leave as little scar as possible upon the lateral surface of the auricle. In contused and lacerated wounds perichondritis almost invariably occurs, and it is well to anticipate such an attack by the application of a wet bichlorid dressing for twelve to twenty-four hours. An attempt should be made to save as much tissue as possible, and no part which possibly may have sufficient vitality to live should be removed. As a primary measure but few sutures should be used, as after the circulation has been thoroughly established it is ordinarily a simple matter to secure more perfect coaptation of the parts and prevent deformity. The sutures should not be passed through the cartilage unless absolutely necessary, although no great harm usually results from a suture through the cartilage of the auricle.

Fracture of the base of the skull involving the temporal bone may extend into the auditory canal in some cases without rupture of the membrana tympani. Hemorrhage from the ear may be somewhat profuse or scanty. In addition to the general treatment the ear should be thoroughly cleansed of clots by gentle syringing with a warm bichlorid solution (1 : 5000), dried, and covered with powdered boric acid, except where oozing persists, when the auditory canal should be *very lightly* packed with sterile iodoform gauze. The ear should be gently cleansed once a day with the bichlorid solution and packed with gauze as long as oozing persists; after which the parts are best kept as dry as possible by cleansing when necessary with bichlorid solution, thoroughly drying the parts, and insufflating powdered boric acid. Boric acid in sufficient quantity to cover the wound is apparently sufficient to prevent infection. Packing the canal maintains a warm and moist condition of the wound that should be avoided.

Cleft lobule, which is generally the result of the tearing out of an ear-ring, may be remedied by the following operation: The sides of the cleft are freshened in the same manner as for a hare-lip operation; but, to avoid as far as possible the formation of a conspicuous scar, the sutures should *be introduced* and tied on the inner side of the lobule, and should involve only the deeper layers of the skin on its outer surface.

Keloid of the auricle originating in the scar resulting from piercing the ear for ear-rings is not uncommon, especially in the negro. The growth consists of a hard nodule of fibrous tissue, generally tender on pressure. If large, it should be removed by the knife. There is a tendency for the growth to recur. Encouraging results have been reported from the application of the *x*-ray in cases where the growth has recurred after removal by the knife.

The **cutaneous diseases** which sometimes attack the auricle are hyperemia, frost-bite, burns, eczema, dermatitis, comedo, cyst, erysipelas, syphiloderma, herpes, lupus, and impetigo contagiosa.

Hyperemia may be either active or passive, transient or chronic in character. There is an increase in the blood-supply of the auricle and generally of the canal, so that the skin appears redder than normal and feels hot to the patient. Mild cases are due to some transient vasomotor disturbance that usually soon passes away without treatment. In some individuals a single comparatively small dose of quinin, salicylic acid, or of chlorid of calcium will produce hyperemia of the auricle and canal that may persist for some time.

Active hyperemia of the auricle may result from exposure to cold, sunburn, or other irritants. Passive hyperemia of the auricle and canal are sometimes present as the result of gout, valvular disease of the heart, or any organic disease capable of producing localized blood stasis.

Treatment.—The best local application is probably liquor plumbi subacetatis, which may be painted on the parts once or twice a day. Nervous cases will need building up; the gouty, a correction of the constitutional dyscrasia.

Dermatitis is an inflammation of the skin generally resulting from some injury, such as the bite of an insect, a blow, fall, stab, wound, etc.

The *symptoms* vary from slight inflammation of the skin at the point of injury to localized gangrene.

Treatment.—This varies with the severity of the inflammation and the character of the infection. Mild cases do well by simply painting with liquor plumbi subacetatis. The severer cases require a wet dressing of bichlorid of mercury, as in infected wounds of other parts of the body. The dermatitis following the sting of insects is treated by a wet dressing of 20 per cent. bicarbonate of sodium.

Frost-bite.—In cold climates frost-bite of the auricle is by no means uncommon. At first the auricle is cold and numb and sometimes stiff, as if actually frozen solid. Later on the symptoms are those of traumatism, involving only the skin or the skin and deeper structures. The skin is hot and swollen, frequently excoriated or covered by vesicles. In the severer cases the symptoms are those of perichondritis, followed sometimes by cartilaginous necrosis and the formation of sinuses upon either surface of the auricle.

Treatment.—When the auricle is frozen its temperature should be restored gradually by gentle friction with snow or pounded ice, and afterward by gentle manipulation with the fingers. If only the skin is involved by the subsequent inflammation satisfactory results will follow the application of a 10 per cent. ichthyol ointment, which should be applied sufficiently often to keep the parts constantly covered and protected. In some cases pain and soreness are greatly relieved by wrapping the auricle in absorbent cotton after using the ointment and applying gentle pressure by means of a bandage. When perichondritis follows frost-bite of the auricle it should be treated in the manner already described. When sinuses have formed, they should be laid open, the necrosed tissues removed, and the wounds allowed to heal by granulation. If care is taken to keep the parts properly supported but little deformity sometimes results.

Cystic tumors are not uncommon and are best dissected out. When this is inadvisable, the cyst should be freely laid open, thoroughly cureted, and its interior painted with tincture of iodin. The wound is then closed with sutures and a wet bichlorid dressing applied.

Burns.—The auricle is liable to burns, sometimes severe, and involving not only the surrounding neck and scalp but also the auditory canal. A common cause of slight burn of the auricle sufficient to raise a blister is hot applications for the relief of the pain of otitis media.

Treatment.—Pain is best relieved by the local use of cold, applied either in the form of an ice-bag or napkins wrung out of ice-water. The application of cold should be continued as long as it affords relief.

Charred and dead tissue, if the burn is a severe one, should be at once removed, and the parts cleansed from soot and dirt by means of copious washings with a solution of bicarbonate of sodium. The parts are then dusted with orthoform or smeared with a 3 per cent. carbolized petroleum, a bandage applied, and over this an ice-bag is placed as long as the cold seems necessary for the relief of pain. Excessive pain if not quickly relieved by these measures will require a hypodermic of morphin.

When the skin is unbroken the best dressing is the so-called carron oil (equal parts of linseed oil and lime-water). This is smeared thickly on patent lint and applied to parts after they have been cleansed with bicarbonate of sodium solution.

Herpes of the auricle is similar to the disease in other localities. It is characterized by vesicles filled with a clear serum, appearing singly or in groups, upon the helix or about the lobule. The surrounding skin is reddened, slightly swollen, and tender to the touch. There may be slight fever, pain, and itching of the auricle. The affection is due to some nervous disturbance. The vesicles ordinarily dry up and disappear by the end of ten days or two weeks.

Treatment.—The milder cases are best treated by gentle purgation with citrate of magnesia or one of the other salines.

The vesicles should be painted three or four times a day with camphorated tincture of opium (paregoric). This application seems to allay the slight itching and burning better than most others and hastens absorption. Should the contents of the vesicle become purulent, the vesicles should be opened and the parts washed with bichlorid solution and dusted with powdered calomel.

Impetigo contagiosa is an acute contagious disease of the skin sometimes encountered upon the skin of the auricle or nose in dispensary practice. It begins as small discrete or confluent vesicles, which rupture and leave a granular surface resembling closely a vaccination sore. It is contagious. Recovery usually occurs within a week under antiseptic treatment.

Treatment consists in keeping the parts clean by washing with bichlorid solution and applying either powdered calomel or an ointment of ammoniated mercury.

Lupus vulgaris is a chronic tuberculosis of the skin of the auricle, either primary or extending to the auricle from the skin of the face. The disease begins as a tubercle deep in the skin. The dull reddish tubercles are sometimes years in developing, but finally break down into a characteristic ulceration which may heal at one extremity while it is spreading in another direction. The disease is exceedingly chronic and years may go before a large portion of the auricle is involved. After healing has occurred the auricle is shriveled, shrunken, and deformed.

The *diagnosis* is usually made by the appearance of the ulcer and the history of extreme chronicity. The disease might be mistaken for either syphilis or epithelioma, but each is much more rapid in its course.

Treatment.—The internal medication consists in the administration of cod-liver oil and arsenic. The local treatment consists in a thorough cureting of the ulceration and the application of the solid stick of nitrate of silver. This should be followed by applications of the *x*-ray.

Syphilis.—*Primary syphilis* of the auricle is naturally rare, but the auricle may become inoculated by a bite or other cause. Chancre of the auricle differs in nowise from the primary lesion elsewhere upon the skin. It is an ulcer with indurated edges and a hard base, generally conforming to the papular type. The lymphatics of the neck are swollen.

Secondary syphilis of the auricle is generally part of a syphiloderm involving more or less of the whole body.

Tertiary syphilis of the auricle consists of a gumma either before or during the stage of ulceration.

The *diagnosis* of the primary lesion is sometimes difficult unless there is a history of a bite or injury by a syphilitic individual. The diagnosis in the secondary stage is usually easy. In the *tertiary stage*, however, an ulcerating gumma may be mistaken for either lupus or epithelioma.

Treatment.—The constitutional treatment differs in nowise from that of syphilis of the nose, pharynx, or larynx already described.

Congenital syphilis is usually of the tertiary variety. Its treatment differs in no respect from the acquired disease. The writer remembers only one case observed by him, that of an infant about eight months old, with an ulcerating gumma of the meatus. The external orifice of the meatus was nearly occluded by exuberant granulations, which were snared away and the parts kept clean and dusted with calomel powder. The internal treatment consisted of gray powder and inunctions of mercury. The infant made a good recovery.

Erysipelas is the result of infection of the skin with the Streptococcus erysipelatis of Fehleisen. It is presumed to only invade the skin through some traumatism, possibly so minute as to be overlooked. The writer saw in consultation two cases that had their origin in a blister produced by painting the mastoid process with cantharidal collodion. In both these cases, occurring in old men, the erysipelas extended to the scalp; in one with a fatal result. Erysipelas of the auricle may extend along the canal and involve the drum-head.

The *symptoms* are those of erysipelas in other localities. The disease is usually ushered in by a chill and high temperature. There is headache and anorexia. The infected area is red and swollen and the swelling and redness somewhat rapidly spread until sometimes the entire auricle is involved and the disease has attacked adjacent skin areas. Vesicles filled with serum may or may not appear.

Treatment.—The patient, if in a hospital, should be isolated from other surgical cases. It is well to begin treatment with a calomel purge ($\frac{1}{5}$ gr. every hour until 1 gr. has been taken), followed by a bottle of the solution of citrate of magnesia. As soon as the bowels have acted freely the patient should take 20 drops of the tincture of the chlorid of iron every two or three hours and $\frac{1}{30}$ gr. of strychnin every four hours. It is said that some cases can be aborted by painting the infected and adjacent skin area with carbolic acid, which is allowed to remain until it has blanched the skin surface. The excess of acid is then washed off with alcohol. Most of the writer's cases have been treated locally by application of 20 per cent. ichthyol in lanolin, which was smeared thickly on patent lint and applied to the parts. The treatment is effective, but somewhat dirty. Those cases of facial erysipelas seen in the Philadelphia Hospital during his terms of service there were treated locally by applications of patent lint kept moist with a 10 per cent. solution of protargol. Apparently one treatment was about as effective in controlling the local symptoms as the other. Saturated solution of magnesium sulphate applied cold on patent lint and changed as soon as dry is of considerable value, and also the injection of antistreptococcus serum.

Phlegmonous erysipelas is a severe form of erysipelas involving the deeper structures beneath the skin, with the formation of abscesses. It is generally the result of mixed *infection*, the Streptococcus erysipelatis and the Streptococcus or Staphylococcus pyogenes being found in the discharges.

The *symptoms* are those of severe erysipelas—high fever, redness, pain, and great swelling of the auricle, with formation of pus and exfoliation of cartilage.

Treatment.—The auricle should be covered with a dressing kept constantly wet with bichlorid solution (1 : 2000). As soon as the presence of pus is suspected the parts should be freely incised down to the cartilage. The wound should be syringed daily with a bichlorid solution and, if necessary, packed with gauze in such a manner as to secure perfect drainage.

Gangrene is, in modern times, an extremely rare disease, but is said to occur occasionally either in the moist or dry form.

Treatment.—This is similar to that of phlegmonous erysipelas. Iron and strychnin should be given internally. The parts should be kept covered with a wet bichlorid dressing and every effort made to secure asepsis. The necrotic tissue should be removed as soon as possible. Localized pain can be controlled by dusting with iodoform and, when this is ineffective, with orthoform.

The disease is very contagious, at least to other surgical cases.

Therefore the patient should be carefully quarantined and all dressings, towels, etc., used about the case destroyed.

Eczema is by far the commonest of the skin diseases affecting the auricle. It may also involve the auditory canal and even the dermoid layer of the membrana tympani. Intertrigo resulting from the invasion by the disease of the fissure formed by the junction of the auricle with the mastoid region is of frequent occurrence in infants and young children.

Treatment.—In adults the disease is sometimes the result of the rheumatic or gouty diathesis, and, in addition to local treatment, such cases require the administration of alkalies, with iodid of potassium, salicylate of sodium, or arsenic. In children the disease is frequently associated with struma, and for such cases cod-liver oil or syrup of the iodid of iron should be prescribed. Eczema intertrigo is best treated by the frequent application of powders, and oxid of zinc or subnitrate of bismuth may be prescribed for this purpose.

The commonest *cause* of eczema of the auricle in children is an irritating discharge from the middle ear. In the neglected infants of the poor the discharges resulting from purulent inflammation of the tympanum are frequently smeared by the fingers of the child over the entire auricle and over the skin in front of and behind the ear. Under such circumstances the auricle and surrounding skin become covered by eczematous scabs and crusts. These the surgeon should carefully remove by means of pledgets of cotton saturated with hydrogen peroxid, and rub well into the affected parts an ointment consisting of 6 or 8 gr. of the yellow oxid of mercury to 1 ounce of petrolatum. A single thorough application of this remedy is sometimes sufficient to bring about great improvement, even in cases in which the disease has existed for several months. Perfect cleanliness in all cases should be enjoined, and if frequent cleansing of the auditory canal with absorbent cotton, followed by insufflations of powdered boric acid, is not sufficient to keep the concha dry and free from the discharge, the skin of this part of the ear should be protected by some bland ointment. Benzoated zinc ointment, if *fresh* and properly made, answers very well for this purpose.

The **new growths** that occur on the auricle are sebaceous cyst, fibroid tumor, epithelioma, nevus, sarcoma, and cornu cutaneum.

The *treatment* is the same as if the new growths occurred elsewhere. Nevi in suitable cases should be treated by electrolysis. The other growths ordinarily require excision.

DISEASES OF THE EXTERNAL AUDITORY CANAL

The more common affections of the external auditory canal are acute circumscribed inflammation or furunculosis, acute and chronic diffuse inflammation, diphtheric inflammation, hyperostosis, exostosis, and foreign bodies.

Furuncle or Acute Circumscribed Inflammation.—Recurrent attacks of furunculosis of the auditory canal seem, in many instances, to be the result of irritation from carious teeth or from disease of the interior of the nose and throat. The affection is commonest in gouty or anemic and debilitated individuals and in women suffering from menstrual disorders.

Pathology.—In most instances the starting-point of the disease is a sebaceous gland or a ceruminous follicle, which has become inoculated with the Staphylococcus pyogenes aureus or other pus-forming bacteria by scratching the ear with a dirty finger-nail, hairpin, match-stick, etc. Metastatic abscess in the canal is said to sometimes occur in gonorrhea. The inflammation usually soon becomes a circumscribed perichondritis or periostitis of the auditory canal. The pathology of acute circumscribed inflammation of the external auditory canal is similar to that of boils and felons occurring elsewhere on the body.

Symptoms.—There is at first an itching within the canal, a portion of which is found tender to the touch, and soon becomes painful. The pain and tenderness increase, until in some instances the patient's sufferings become almost unendurable. In severe cases the pain, which at first was confined to the ear, extends to the whole side of the head, is throbbing in character, and is increased by movements of the jaw in talking, eating, etc. There is some elevation of temperature in the severest cases. Deafness is not a marked symptom until the swelling is large enough to close the canal at the part involved, but tinnitus is present in the majority of cases. The furuncle will rupture spontaneously in from two to eight days, according as the inflammation is ficial or deep seated. The disease is purulent, sometimes quite profuse, and its appearance is speedily followed by a subsidence of acute pain; the parts, however, remain sore for several days. A "core" or small slough of the skin, as in boils elsewhere, usually exfoliates before the parts heal.

Treatment.—Speedy relief generally follows a free incision through the swollen parts down to the cartilage or bone, even though no pus be found. The incision should be followed by syringing the canal with hot boric acid solution, the insertion into the canal of a cone of absorbent cotton covered with a 10 per cent. ointment of cocain in lanolin, and the application of heat.

In cases where incision is not advisable, a cone of cotton should be well covered with an ointment of the yellow oxid of mercury, 6 gr. to an ounce of vaselin, and so placed within the canal that it will exert pressure upon the swollen parts. For a few moments this procedure increases the pain somewhat, but it is followed by a feeling of decided relief and comfort. The ointment is rubbed into the skin of the canal by each movement of the jaw in talking and eating, and if the treatment is applied early enough many cases of furunculosis of the auditory canal may be aborted before suppuration has occurred. Cotton cones are readily made by selecting a piece of absorbent cotton about 2 inches long and about $\frac{3}{4}$ inch wide. The two ends of the piece of cotton are than frayed out until the center of the cotton is thicker than the edges. The cotton is then folded through its thick *central portion*, so that the thin edges are brought together

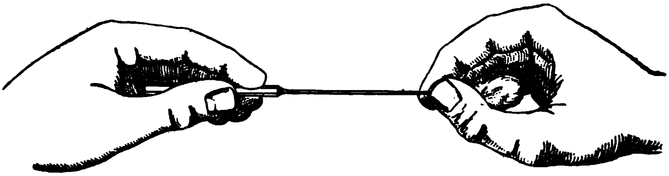

Fig. 146.—Method of wrapping cotton about the end of an Allen probe to form a brush for cleansing the canal, applying pigments, etc.

and a wedge is thus formed, one edge being very thick and the other thin. This wedge is now wrapped somewhat firmly about the end of an Allen ear probe (Fig. 147), the thick edge of the cotton wedge toward the handle of the instrument, in such a manner that the thin edge of the cotton wedge forms the pointed end of the cone. The cone thus made should be firmly enough wrapped about the probe to be smooth and taper evenly from apex to base. When made it is coated thickly with the appropriate ointment and inserted gently into the canal until its wedge-like pressure begins to cause pain. The probe is then dislodged from the cone by turning it in the opposite direction to that in which the cotton was wrapped about it and steadying the cone with a touch of the left forefinger so that the cone is not withdrawn from the canal with the probe. If after a few moments the pressure of the cone instead of affording relief causes increased pain, the patient can withdraw it slightly and after an interval again push it more deeply into the canal.

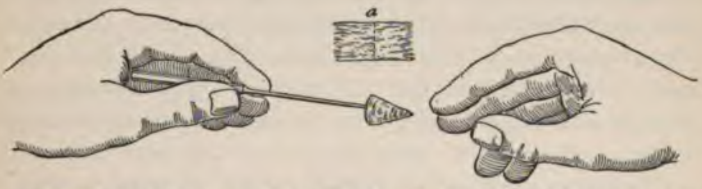

Fig. 147.—Method of wrapping cotton about the end of an Allen probe so as to form a cone for applying pressure within the auditory canal. A piece of absorbent cotton is frayed out to thin edges, folded through the center (dotted line *a*), and wrapped about the end of the probe.

Some relief from pain follows the application of a 10 per cent. ointment of cocain in lanolin or a 1 per cent. ointment of atropin. Heat, however, generally gives speedy relief from pain. It may be applied by gently syringing the canal with hot water, or by resting the head upon a hot-water bag or a bag of hot salt or of hops. In severe cases it is advisable to secure a free evacuation of the bowels by means of small, frequently repeated doses of calomel and bicarbonate of sodium; 1-drop doses of tincture of aconite-root, repeated every hour, will control to a certain extent fever and pain. In all cases the cause of the attack should carefully be sought and measures adopted to prevent a recurrence. To prevent inoculation of other parts of the canal and producing a so-called "crop" of boils, the canal should be carefully cleansed either by syringing gently each day with a warm 1 : 5000 bichlorid solution or by simply wiping out the pus with absorbent cotton and afterward sterilizing the skin of the canal by painting it with a 12 per cent. solution of silver nitrate.

Otitis Externa Diffusa Acuta.—Diffuse inflammation of the auditory canal varies in character from a simple erythema of the skin of the auditory canal to severe periostitis. The disease usually attacks the osseous portion of the canal, but it may extend to the auricle, and, by periosteal continuity, to the periauricular and mastoid regions, causing abscess and necrosis.

Etiology.—The disease usually occurs in persons whose general health is impaired. It is sometimes consecutive to an attack of otitis media acuta or it may be caused by an irritating discharge from the middle ear. The affection, which usually begins in the skin or cellular tissue, may extend to the periosteum and bone.

The *symptoms* are similar to those of furuncle of the auditory canal, except that the pain is usually more intense and appears at an earlier stage of the disease, while deafness and tinnitus are more marked and long continued. On inspection the tissues of the auditory canal appear red and swollen. The swelling is usually greatest in the bony portion of the canal, where it may be so great as to completely obliterate the canal and prevent a view of the drum-head from being obtained. Generally the skin is excoriated at points where the inflammation is greatest, and usually there is desquamation and a slight watery discharge.

Treatment.—Incision of the swollen tissues is rarely necessary unless an abscess has formed. Pain can generally be alleviated very much, if the case is seen early, by the application of a large leech to the skin in front of the tip of the mastoid, as closely as possible beneath the auditory canal. A leech also may be applied in front of the tragus and one on the mastoid, as close to the canal as possible.

In many cases it will be necessary to prescribe morphin to completely control the pain and secure sleep; but *heat*, applied in the manner already described, will be all that is necessary in the majority of instances. The canal should be cleansed and carefully dried with absorbent cotton and the parts painted with a 12 per cent. solution of nitrate of silver and dusted with powdered calomel. This should be done every day as long as the symptoms are acute, and afterward, as the disease subsides, at longer intervals. In using an insoluble powder like calomel within the canal care should be exercised not to employ a quantity sufficient to form a hard crust and cause pain.

Otitis Externa Hæmorrhagica.—The hemorrhagic blebs sometimes occur in the canal from traumatism or as a complication of influenza or otitis media. The blebs are bluish, easily ruptured, and contain bloody serum. They should be broken with a cotton-tipped Allen applicator, touched with a 12 per cent. solution of silver nitrate, and then dusted with calomel or powdered boric acid.

Otitis externa diffusa chronica occurs in individuals whose health is impaired, or it may be the result of the gouty or rheumatic diathesis, or the irritation caused by carious teeth, or disease of the nose and throat. The growth of aspergillus within the inflamed canal may be a complication or a cause of disease.

Symptoms.—Patients complain of itching and a sense of heat within the canal. Pain is usually absent except during acute exacerbations. Upon inspection the skin of the auditory canal is found to be red and swollen, especially in the deeper portions. The inflammation may be of the eczematous or desquamative type and accompanied by a watery discharge or seborrhea.

Treatment.—The cause of the affection should be carefully sought. Patients of the strumous diathesis or in feeble health will require cod-liver oil and tonics, and appropriate remedies should be prescribed for those in whom the disease seems to be the result of the rheumatic or gouty diathesis. If carious teeth are present they should receive the attention of a skilful dentist, and any disease of the nose or throat that may be present should be properly treated. The local treatment of chronic diffuse inflammation of the external auditory canal varies according to the stage and variety of the disease. When the disease is of the eczematous type all scales and scabs should be removed with a pledget of absorbent cotton wrapped about a probe and dipped into a solution of hydrogen peroxid, and yellow oxid of mercury ointment well rubbed into the parts. When there is considerable secretion of watery fluid the canal should be dried thoroughly and brushed with a solution of silver nitrate (12 per cent.) and covered with powdered calomel.

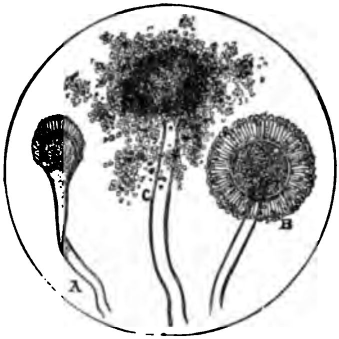

Fig. 148.—*A*, Aspergillus glaucus; *B*, Aspergillus niger; *C*, ripe fructiferous head of Aspergillus niger throwing off spores (Burnett).

Mycosis or **otomycosis** is an inflammation of the external auditory canal due to the presence of a fungus. Aspergillus glaucus (Fig. 148, *A*) and Aspergillus niger (Fig. 148, *B*, *C*) are the varieties most frequently met with. The presence of molds in chronic inflammation of the external auditory canal may be the cause of the inflammation or only a complication of the disease.

The *symptoms* are those of an acute or chronic inflammation of the canal, except that when there is a large mass of mold present filling the fundus of the canal the patient will be deaf from the accumulation. This is usually a pasty, whitish material interspersed with black spots looking not unlike a wad of wet newspaper. The microscope will detect the presence of either or both the Aspergillus glaucus or niger or some other species of aspergillus or mucor.

Treatment.—When aspergillus is present, the canal should be cleansed thoroughly each day with hydrogen peroxid and an application made of a 12 per cent. solution of silver nitrate or of alcohol. It is essential that the canal should at all times be kept absolutely dry, because nothing more favors the growth of the aspergillus than moisture. Discharges should be absorbed by the application of powdered boric acid.

Otitis Externa Diphtheritica.—Diphtheric inflammation of the integument of the external auditory canal is an inflammation characterized by the presence of a pseudomembrane, which when removed leaves a bleeding surface. The pseudomembrane should contain the Klebs-Löffler bacillus characteristic of true diphtheria, as other bacteria are capable of causing a pseudomembrane within the auditory canal and upon mucous surfaces.

Etiology.—The disease occurs usually as a complication of diphtheria of the throat and middle ear. Primary diphtheria of the walls of the external auditory canal has been observed during epidemics of diphtheria.

Symptoms.—In the primary form there are deafness and tinnitus, with pain. The meatus is greatly swollen. The lymphatics at the angle of the jaw are swollen and tender to the touch. There is usually systemic depression and slight elevation of temperature. Examination discloses the pseudomembrane covering the swollen skin bathed in discharges, so that the canal is nearly occluded, or, if the disease has occurred in a case where the drum-head has been previously destroyed, only the mucous membrane of the tympanum may be occupied by the diphtheric membrane.

The secondary form of the disease sometimes causes destruction of the membrana tympani and the tympanic contents. Occasionally, as in scarlet fever, necrosis of portions of the temporal bone occurs.

Treatment.—The canal should be syringed with a warm bichlorid solution (1 : 1000). The pseudomembrane should then be removed with the forceps and hydrogen peroxid. After the parts have been cleansed of membrane they are dried with absorbent cotton and painted with a 12 per cent. solution of nitrate of silver and covered with a thick coating of boric acid.

Pepsin, trypsin, caroid, and other substances will dissolve the pseudomembrane, but their use is not desirable in the ear because the pseudomembrane soon ceases to re-form when the parts are constantly covered by antiseptics.

Otitis externa crouposa is an acute inflammation of the external auditory canal characterized by the presence of a pseudomembrane which does not contain the characteristic bacilli of diphtheria.

Diagnosis.—The membrane when removed commonly leaves a bleeding surface, as is the case with the pseudomembrane of diphtheria, because croupous membranes rarely if ever occur except upon a skin not already excoriated.

The bacteria are those of a mixed infection, usually streptococcus and staphylococcus.

The *symptoms* are practically those of diphtheria of the external auditory canal, except that the cervical glands are *rarely* as much swollen and inflamed. There is earache, tinnitus, and a greatly swollen meatus, with purulent discharge and, generally, slight fever.

The *treatment* is the same as in diphtheric otitis.

Extostosis and Hyperostosis (Osteomata).—Exostoses of the meatus are usually single and pedunculated. Hyperostoses are situated at the inner end of the meatus close to the membrane, are sessile, and generally multiple (Fig. 149). Both exostoses and hyperostoses are whitish prominences, firm and hard when touched with a probe.

Etiology.—Hyperostoses in most instances are probably congenital, and in all cases their presence and growth are painless, while an exostosis is always preceded by inflammation. A subperiosteal abscess forms over the mastoid, the pus finding its way into the meatus at the junction of the cartilaginous and bony portions of the canal. The mouth of the sinus in this position becomes occupied by exuberant granulations from the bone, which become converted into bone.

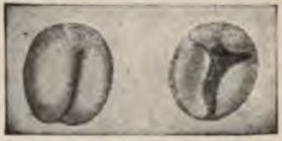

Fig. 149.—Exostoses and hyperostoses (Spalding).

Symptoms.—Hearing is not impaired unless the bony growth or growths are large enough to entirely block the lumen of the meatus. The smallest opening is sufficient to transmit sound-waves. If, however, such a small opening is occluded by a drop of fluid, or by a few scales of epithelium, or by a small mass of cerumen, the hearing at once is greatly impaired. When purulent disease of the middle ear is present the presence of hyperostoses will greatly interfere with drainage and render the disease difficult to cure.

Treatment.—If an exostosis is large and attached by a rather small pedicle to the auditory canal, especially if the growth be slightly movable, it can readily be detached by means of a small chisel and extracted with a pair of forceps. Exostoses of this character should always be removed.

Occasionally *sessile exostoses* are encountered that extend the whole length of the bony canal and encroach upon the position of the drum-head. Under such circumstances it is best to secure additional room for the necessary chiseling by detaching the auricle and cartilaginous canal and pushing it forward out of the way in the same manner as in the radical mastoid operation. The bony canal should be enlarged by the removal of rather more bone than that comprising the exostosis, in order to provide for cicatricial contraction during the healing process. If the cartilaginous portion of the canal is contracted, it should be slit up and the parts adjusted in position in the same manner as after a radical mastoid operation. The more superficial parts of the exostosis are very readily removed by a suitable gouge or chisel; but when the neighborhood of the drum-head is reached it is well to employ a dental burr if the bone is found to lie closely in contact with the drum-head.

Hyperostoses are best let alone, even in those cases in which they encroach upon the canal to such an extent as to decrease greatly its lumen. If from time to time the patient becomes deaf from an accumulation of cerumen between the hyperostoses, this should be picked carefully away be means of an appropriate instrument. The syringe should *not be used* unless absolutely necessary, for it is often difficult to remove fluid from behind the hyperostoses after syringing, and it may be the cause of an inflammation of the auditory canal and drum-head exceedingly difficult to control. Where the presence of hyperostoses seriously interferes with proper drainage in cases of purulent otitis an attempt should be made to effect a removal of one or more of the growths by means of a drill propelled by an electric motor.

Foreign Bodies.—Animate and inanimate objects, impacted cerumen, and laminated epithelial plugs are found in the auditory canal.

Animate objects that may enter the auditory canal are flies and other insects, the larvæ of insects, and various molds.

The *treatment* when the auditory canal is involved by a growth of aspergillus, mucor, or other molds has already been detailed (p. 376). Insects can generally be removed readily by means of the syringe. The larvæ of insects are not usually present unless there be suppuration of the middle ear, but cases have been reported of the presence of maggots within the auditory canal when the drum-head was intact and no suppuration existed. Larvæ can be killed with chloroform vapor and then removed by means of the syringe.

It is not permissible to drop chloroform into the auditory canal, as a blister may result. A part of a drop may be absorbed by a small amount of cotton, which in turn is surrounded by sufficient cotton to make the plug fit snugly into the canal. Used in this manner the chloroform evaporates from the cotton into the canal, and the vapor produces a sensation of warmth and comfort.

Generally the pain caused by the movements of the insects ceases within a few seconds after the use of the chloroform vapor, and the insect may then be removed by syringing or, if necessary, with the forceps. In the case of ants, wood-ticks, or other insects that sometimes attach themselves to the canal of the drum-head by their strong mandibles or jaws, the death of the insect is not always followed by a release of its hold upon the tissues. Under such circumstances the dead body of the insect can be removed by a pair of forceps. In the case of the wood-tick a portion of the tissue to which it has attached itself may be drawn out with the insect. This is a matter of no great consequence when the insect has attached itself to a portion of the canal; but irreparable mischief might be done by ill-considered efforts at removal when the insect has attached itself to the drum-head. It is said that the insect will unclasp its mandibles if touched with a drop of turpentine. In cases where, because of the nervousness of the patient or swelling of the canal, it is impossible at once to remove an insect that has been chloroformed, the canal should be filled with fluid vaselin or some other bland oil to prevent the resuscitation of the insect should the amount of chloroform vapor have proved insufficient to have caused its death.

Inanimate Objects.—Shoe-buttons, pebbles, glass beads, the end of lead- and slate-pencils, and other objects are sometimes placed by children within their ears in a spirit of mischief. It is not rare to find parts of an onion or pieces of cotton that were placed within the auditory canal by patients perhaps months or years before and forgotten. The writer removed from an old gentleman's ear three little wads of cotton which had been placed there several years before when he was treating himself for what he stated was "a boil in his ear." On one occasion, having demonstrated the removal of a foreign body from the ear of a dispensary patient before a ward class of ten or twelve senior students, the writer was requested by one of these students to examine his ear, as he thought he had got sand in it while bathing at Atlantic City the previous summer. There was removed not only a small amount of sand but also a cherry stone, black from age, which the student stated he dimly remembered having placed in his ear when a child. From the ear of another member of this same class was removed a small wad of cotton which the student stated must have been placed there the winter before.

These stories illustrate how little annoyance foreign bodies in the ear sometimes cause. On the other hand, impacted cerumen and other foreign bodies are said to have been the cause of persistent cough, nausea, and even epilepsy. As some sensitive patients cough almost continually while their ear is being cleansed and more especially when the floor of the canal at the junction of the cartilaginous and bony portion is rubbed with a probe, while others become faint and nauseated under similar circumstances, it is readily understood how in a neurotic or hysteric individual the presence of a foreign body in the ear might be the cause of such unusual symptoms.

Among the foreign bodies may be classed impacted cerumen and laminated epithelial plugs.

Removal of Foreign Bodies.—Leaves of the onion, wads of cotton, and other soft objects are readily grasped by mouse-toothed forceps and extracted. Hard round objects, such as shoe-buttons and glass beads, should at first be attacked by means of a syringe. A fine cannula should be placed in such a position that a stream of fluid can be thrown into the auditory canal past the object. If careful syringing in this manner fails to dislodge the foreign body, a delicate hook, made by bending the end of an Allen probe at a right angle (Fig. 150), should be introduced into the canal between its wall and the object, and an effort made to *roll* the object outward through the canal. Hard, irregularly shaped bodies that cannot be rolled out with a hook or grasped with the forceps will often tax the ingenuity of the surgeon to effect their removal. In such cases strong cement or glue may be smeared on the outer surface of the foreign body and then a small mass of cotton applied. After a day or two, when the cotton is firmly attached to the foreign body, the cotton can be grasped with forceps and the foreign body removed.

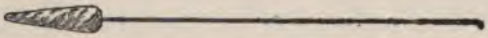

Fig. 150.—Allen's probe bent to hook cerumen, etc.

Efforts at removal of foreign bodies should always be made with extreme gentleness for fear of injuring the drum-head, and the surgeon should bear in mind that rather than incur the risk of doing so it is preferable to detach the auricle from the bony meatus by means of an incision posterior to the auricle, and turn the auricle and cartilaginous meatus forward upon the cheek.

In children it is generally necessary to give an anesthetic to secure that perfect quiescence of the patient necessary for the delicate and careful manipulation of instruments. In difficult cases it is best not to prolong unsuccessful efforts to remove a foreign body, for often it will remain in the auditory canal for years without producing any serious symptoms. In cases where it has been impossible to remove the foreign body at the first sitting, time should be given for the inflammation to subside, and after all swelling of the auditory canal has disappeared, efforts for the extraction of the foreign body will finally prove successful. Seeds and other objects that have swollen by the absorption of water may be dehydrated and shrunken by the instillation of alcohol.

Cases in which the uninitiated, by injudicious and unsuccessful efforts to remove a foreign body, have ruptured the drum-membrane and caused acute purulent inflammation of the middle ear, and in which so much swelling of the canal has arisen that nothing can be seen, should be treated by frequent syringings with warm water and by the use of a hot-water bag, if necessary to relieve pain, until the inflammatory symptoms have subsided and the foreign body can be seen. No attempt at its removal should be made until swelling has subsided and the speculum can be used without causing pain.

Impacted Cerumen.—*Subjective Symptoms.*—There usually is a sense of fulness and itching, and the patient complains that he has suddenly become deaf in one ear without any previous symptoms of inflammation. The explanation of this fact is that so long as there is the smallest conceivable opening through a mass of cerumen it will be sufficient to transmit sound-waves and the hearing will not be greatly impaired. Sometimes a small opening through a mass of cerumen will close from time to time during damp weather and open again when the atmosphere becomes dry. This phenomenon may be repeated many times, the patient being deaf only during damp weather. Even when impacted cerumen is present in both auditory canals the patient usually becomes deaf in one ear first. Under such circumstances the larger amount of inspissated cerumen may be removed from the ear in which the hearing is most nearly perfect, sometimes after the patient has protested that "there is nothing the matter with that ear."

Etiology.—Increased secretion of cerumen is usually the result of disease of the middle ear or of catarrh of the nose and throat. It is rather unusual to find the hearing perfect after the removal of a mass of impacted cerumen. The introduction of irritants within the auditory canal increases the secretion of cerumen.

This is true of dusty employments, like coal-mining, stoking, or milling. Under such circumstances the mass of cerumen removed may consist partly of coal-dust or flour introduced into the canal by the dirty fingers of the workman while endeavoring to relieve the irritation of the canal by scratching it. Impactions result from ill-advised efforts to cleanse the canal by inserting into it the screwed-up corner of a towel or the clumsy use of a match-stick or ear-spoon. When such articles are used dead epithelial scales and inspissated cerumen are thrust deep into the canal, which, if left to themselves, would have scaled off or exfoliated and dropped out of the canal.

Treatment.—If the mass be soft, syringing with warm water will quickly remove it. Although inspissated cerumen is perhaps as readily soluble in water as any other bland fluid except hydrogen peroxid, a 5 per cent. solution of sodium bicarbonate in glycerin and water is sometimes prescribed to be dropped into the ear several times a day to soften inspissated cerumen before efforts are made to extract the mass by syringing.

However, it should be borne in mind that the hearing will be temporarily impaired as the result of dropping any fluid into the auditory canal when it contains a considerable quantity of cerumen, for reasons stated above. After the lapse of a few hours the wax may in rare instances have been increased in bulk sufficiently to cause pressure pain. When the surgeon is sufficiently expert with hook and syringe, it is never necessary to employ any fluid to soften the cerumen, the removal of the hardest and largest specimens being the work of only a few moments.

When the impacted cerumen is very hard and firmly fixed within the auditory canal it is probably best not to attempt to remove it by syringing until the mass has been rendered movable by manipulation with instruments. For this purpose the tip of an Allen steel probe, bent at a right angle (Fig. 150), should be introduced flatwise between the wall of the canal and the cerumen until it has penetrated a short distance, when the hook should be turned into the mass of cerumen and gentle traction exerted. Generally there will be detached a small portion of the impacted cerumen, which can easily be removed from the canal. Proceeding care-

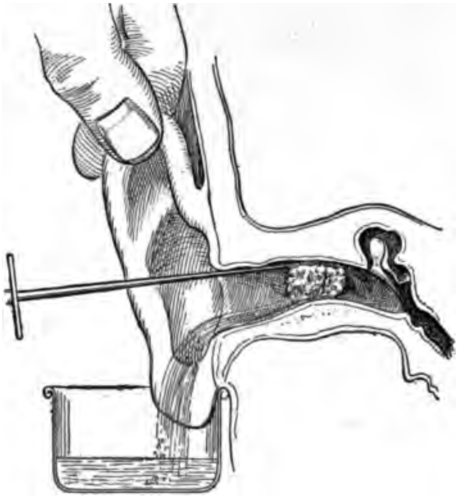

Fig. 151.—Washing impacted cerumen from canal. Showing how to hold auricle to straighten canal and where to direct the stream of water.

fully in this manner it is sometimes possible to remove, even in those cases in which the wall of the canal is very sensitive, the entire mass of impacted cerumen without causing even the slightest pain or congestion of the drum-head, the procedure being vastly less disagreeable to the patient than syringing. However, it is best in many instances to desist as soon as the mass of cerumen is felt to be movable, and resort to the syringe. The syringe used by dentists to cleanse carious cavities in teeth (Fig. 28, *c*, with nozzle 8) is an admirable instrument for syringing cerumen from the ear. The stream of fluid should be thrown behind the impacted cerumen through the opening that has been made by an instrument (Fig. 151). One or two syringefuls of warm water will probably suffice to remove the greater portion of the cerumen, after which the auditory canal should carefully be cleansed of any remaining flakes by a dossil of absorbent cotton wrapped about the end of an Allen probe and dipped into the solution of hydrogen peroxid.

A metal ear-spout (Fig. 152) will be found convenient to receive the fluid from the auditory canal during the syringing. It should be borne in mind that syringing an ear is at best a disagreeable procedure, and that the injection of water either too cold or too hot or with too much force into the auditory canal is usually followed by syncope. Where the quantity of cerumen is so large that it is impossible for the first syringeful to reach the drum-head, it is justifiable to inject with considerable force, but as the tympanum is approached judicious gentleness should be employed. Especially where the drum-head is lacking, syringing the ear may be made absolutely intolerable by want of gentleness and judgment on the part of the operator.

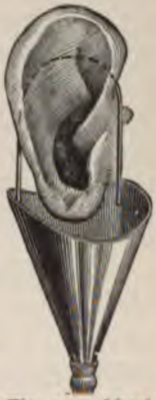

Fig. 152.—Metal ear-spout.

Keratosis Obturans or Epithelial Plug.—In masses of impacted cerumen there are more or less epithelial laminæ. However, the typic laminated epithelial plug consists almost entirely of laminæ of epithelium packed one about the other. The external end of such a mass is generally covered by inspissated cerumen which, of course, is easily removed by syringing when the laminæ of closely packed epithelial scales are exposed to view, looking not unlike a plug of wet chamois skin. It is impossible to remove such an accumulation by syringing. It is necessary to effect its removal layer by layer by means of a hook, a curet, or by forceps. A laminated epithelial plug is composed of the horny layer of the cutis of the auditory canal, which accumulates, layer by layer, within the canal as the result of desquamative inflammation. After the removal of a laminated epithelial plug the membrana tympani will probably be found normal in appearance and the hearing be perfect. Usually this is not the case when the collection within the ear consists of a cholesteatomatous mass.

DISEASES OF THE MIDDLE EAR

THE MEMBRANA TYMPANI

When inspecting those parts of the ear visible by otoscopy the attention of the observer should be particularly directed to the size of the auditory canal and the condition of its wall. Every little scale of epidermis or mass of cerumen that can possibly hide an abnormal condition should carefully be removed by means of a cotton-tipped probe. The observer's eye should next seek the umbo or depression near the center of the drum-head, and the glance should then be directed upward along the handle of the malleus until Shrapnell's membrane is brought into view. This portion of the membrane should receive the most careful scrutiny, an effort being made to discover, if possible, the presence of the so-called *foramen of Rivini* or anything abnormal in this region. Attention should next be directed to the condition of the anterior and posterior folds, after which the glance of the observer should be directed around the periphery of the drum-head. By observing always this or some other definite plan of examination during otoscopy it will hardly be possible that any abnormal condition of importance will escape the observation.

Particular attention should be directed to the size, shape, and position of the cone of light, the apparent length and position of the malleus handle, and the degree of prominence of the short process; the color, luster, apparent thickness, curvature, and position of the drum-head; as well as the presence or absence of perforations, cicatrices, chalk deposits, localized spots of atrophy or thickening, polypi, abscesses, exudation-cysts, or other pathologic conditions.

Changes Occurring in the Curvature of the Membrana Tympani.—The membrana may bulge outward as the result of pressure from fluid within the tympanum or there may be a localized "pointing" of pus at any position on the drum-head. The normal curvature of the drum-membrane depends largely upon the tension of the tensor tympani muscle. It is claimed that the retractile effect of this muscle is increased after death by rigor mortis and in certain conditions the muscle is constantly contracted during life to an extreme degree.

An unduly depressed condition of the membrana tympani also occurs as the result of unequal pneumatic pressure upon its two surfaces when obstruction of the eustachian tube interferes with the proper ventilation of the tympanic cavity. Sometimes the retraction of the membrane is quite abrupt at points near the periphery, so that a sort of terrace is formed at that point. Under such circumstances a bright line will be seen at the point where the abrupt change of curvature occurs. Should such an abrupt change of curvature occur at the position of the cone of light, it will appear as if broken transversely into two parts, that nearest the periphery assuming a crescentic shape. Whenever the membrane is retracted as a whole there is usually some change in the light spot. It often loses the triangular form, because of which it has received the name "cone" or "pyramid of light," and becomes narrow, reduced to a mere point, or perhaps entirely disappears.

The posterior fold becomes large and prominent when the drum-membrane is greatly retracted and the malleus handle foreshortened (Fig. 153) or displaced, usually backward (Fig. 154). The two diagrams (Figs. 155, 156) represent the means by which the apparent shortening of the malleus handle is produced.

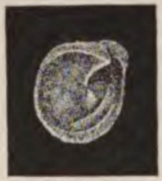

Fig. 153.

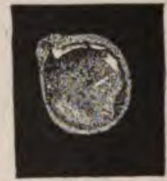

Fig. 154.

Fig. 153.—Retracted membrane of a girl of ten years, with long-standing nasal and tubal obstruction, showing foreshortening of malleus handle, prominence of the posterior fold, and visibility of the margin of the pocket of von Troltsch as it passes forward to the manubrium. The light spot is shortened, and beyond it anteriorly are two parallel curvilinear bright lines, marking the edges of abruptly depressed areas of the drum-head, one within the other (Randall).

Fig. 154.—Left membrana tympani of a boy of six years, with nasal and tubal obstruction. The manubrium is drawn up almost out of sight; the tip being higher than the short process; behind it the incudostapedial joint is visible, and below and posteriorly the dark niche of the round window is discernible. There is a faint reflection of light near the normal position, and a stronger one on the promontory near the stapes (Randall).

Myringitis is an inflammation of the membrana tympani, characterized by congestion, swelling, and sometimes ulceration of the membrana tympani, pain, and tinnitus; but hearing is not greatly impaired unless the inflammation also involves the entire tympanic cavity. The pain is increased by movements of the jaw, pressure in front of the tragus, or traction upon the auricle; it is generally shooting rather than throbbing in character.

Etiology.—The commonest cause of myringitis is exposure to cold, especially the direct impact of a cold wind upon the membrana tympani in persons whose auditory meatus is unduly open. It is sometimes the result of direct violence, as, for example, a blow upon the auricle or the impact of a wave in surf-bathing. In some cases the etiology is obscure and the disease seems to be the result of struma or of the rheumatic or gouty diathesis.

Symptoms.—Severe pain, shooting in character, tinnitus, and more or less deafness. Upon inspection, if the disease is seen in its earlier stages, the membrane will be found markedly congested at the periphery and behind the malleus handle. Large vessels will be seen in these positions and radiating branches will extend from the blood-vessels behind the malleus handle to inosculate with those coming from the periphery. The surface of the membrane becomes lusterless and rough from loosening of its epithelium, and thick and opaque and of a uniform reddish color from infiltration and increased congestion, until all landmarks except the short process of the malleus handle are hidden from view, this, too, finally disappearing beneath the swelling, the membrane being, at this stage of the disease, of a lively red color and apparently either flat or actually convex in form. As the integument in the neighborhood of the drumhead is also congested it is difficult to make out its bound-

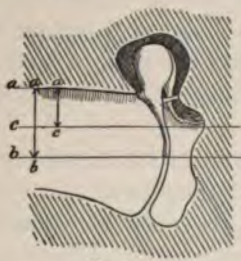

Fig. 155.

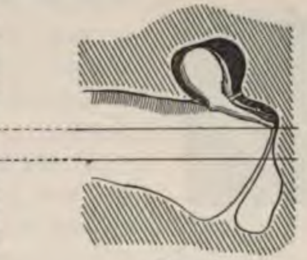

Fig. 156.

Fig. 155.—Diagram of the normal position of the malleus and membrana tympani. The apparent length of the malleus handle to the eye of an observer is represented by the distance *a–b*.

Fig. 156.—Diagram of a retracted membrana tympani, showing the malleus handle drawn backward until its tip is in contact with the promontory. The apparent length of the malleus handle to the eye of an observer is represented by the distance *a–c*, the apparent length of the malleus handle having been "foreshortened" about one-half.

aries, the red and convex membrane appearing not unlike a polypus projecting into the canal, for which it has been mistaken.

In the course of the disease the epidermis exfoliates wholly or partly, and there appears an abundant secretion, which is at first serosanguineous, but later becomes purulent. Exudation-cysts, filled with serum or pus, sometimes appear upon the surface of the drum-head. Pressure with a probe will indent such collections of fluid between the layers of the drum-head, and the indentation will remain visible for some time (Fig. 157), which is not the case in localized pointings of pus from within the tympanum. If abscesses rupture or are incised, ulcers result, which may either heal or perforate the drum-head.

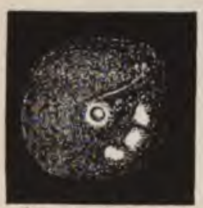

Fig. 157.—Interlamellar abscesses of right membrana tympani, one at umbo showing the pitting caused by pressure of a probe. Three others are seen down and forward (Schwartze).

As the inflammation subsides the portion of the membrane at the umbo is the first to resume its normal appearance. The periphery of the drum-head and a triangular portion, whose base includes Shrapnell's membrane and whose apex is at the tip of the malleus handle, remain red and swollen for some days. Finally, the swelling and congestion disappear from these parts of the membrane, the light spot becomes distinct, and the drum-head assumes its normal appearance.

Relapses are not infrequent or an acute attack may assume the chronic form of the disease.

Treatment.—In acute cases pain may be relieved by the application of leeches and afterward by the use of hot fomentations. When a discharge appears the parts should be thoroughly cleansed by means of a dossil of cotton dipped into hydrogen peroxid and the membrane should be covered *with a thin coating* of powdered boric acid. In traumatic cases the pain and congestion rapidly subside under 1-drop doses of tincture of aconite root administered every hour. A 4 per cent. solution of cocain should meanwhile also be dropped into the auditory canal sufficiently often to keep the parts moistened until the pain subsides.

Chronic Myringitis.—Chronic inflammation of the drum-head is practically always present in chronic otorrhea originating in the tympanic cavity. In such cases the chronic myringitis is part of the intratympanic inflammation and generally subsides after the discharge has ceased. The perforation, if not too large, then closes spontaneously or can be made to close by one of the methods described in the section on Perforations of the Membrana Tympani.

However, chronic myringitis is occasionally encountered without a history of previous middle-ear otorrhea, and then generally is part of a chronic inflammation involving at least the deeper portion of the auditory canal.

Etiology.—Gout, rheumatism, or struma may account for the cases of chronic myringitis when there is no history of a previous otorrhea. Most cases are, however, the heritage of a middle-ear suppuration, and in cases where there is a scanty fetid discharge in the fundus of the canal it is well to inspect the posterior upper quadrant of Shrapnell's membrane closely for a fistula leading into the attic before being satisfied that the drum-head is intact.

Symptoms.—The subjective symptoms are a sensation of fulness and itching within the ear. As the drum-head has little to do with the function of hearing, the hearing in these cases is only slightly impaired unless the intratympanic structures are involved. There is sometimes a very scanty fetid discharge. This discharge adheres to the drum-head and collects in small amounts upon the adjacent lower portions of the canal. When wiped away with cotton and peroxid the drum-head is reddened, either as a whole or in spots where the epithelium has exfoliated. Some of these areas mark the position where a minute abscess has ruptured and may be covered with granulations or minute polypi. In cases where there is no discharge the drum-head lacks luster and is rough from the loosening of its epithelium. The color of the drum-head varies, according to the degree of the inflammation, from a dull red to a yellow or dirty white. It is no longer translucent, but is thick and opaque. The cone of light is absent or small and distorted.

Prognosis.—The course of the disease is slow. Chalk deposits and areas of localized thickening or atrophy are not uncommonly seen when the disease has run its course.

Treatment.—When chronic myringitis is part of an inflammation of the other anatomic structures of the tympanum the treatment is largely that of the intratympanic condition.

In cases where there is a *discharge* from the dermic surface of an intact drum-head, this should be cleansed carefully by syringing first with warm water and afterward with sublimate solution. The canal should then be dried thoroughly by means of absorbent cotton wrapped about the end of an Allen probe and painted with a 12 per cent. solution of silver nitrate.

Abscesses, if present on the drum-head, should be evacuated and the interior of the abscess touched with silver nitrate by means of a bead of the salt fused on the end of a probe.

Granular spots and small *polypi* upon the drum-head should receive special attention. Where the granulations are small, simply thoroughly applying at intervals of three or four days a 12 per cent. solution of silver nitrate is sufficient to bring about a cure. When the granulations are larger and coarser it will be necessary to destroy them with a 50 per cent. solution of chromic acid or by touching them with trichloracetic acid. These applications should be made with care, so that no drip of acid is allowed to flow or spread beyond the bounds of the granular area. Polypi too small to be removed with a snare should be scraped away from their place of origin on the membrana with Buck's sharp curet or removed by means of Hartmann's curet forceps (Fig. 158).

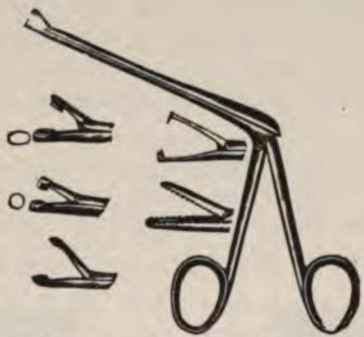

Fig. 158.—Hartmann's foreign body and polyp forceps.

In cases where the granulations on the drum-head are coarse or a small polypus has been removed, the patient should be instructed to drop into his ear 95 per cent. alcohol (Formula 16), diluted if necessary, every three hours between his visits to the aurist.

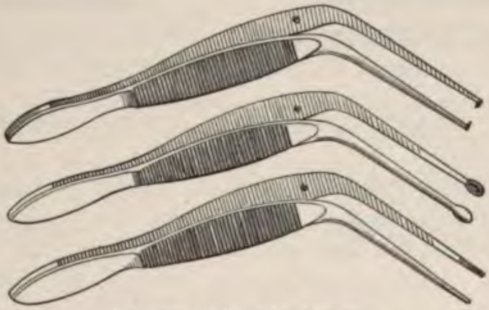

Fig. 159.—Politzer's ear forceps.

Silver nitrate in strong solutions was extensively used by the aurists of half a century ago as an application to the drum-head. Wilde believed that it brought about exfoliation of the dermic layer of the membrana and thus diminished its thickness. While the views of this distinguished Dublin aurist are not in harmony with modern teaching, yet it is probable that the silver oxid deposited upon the dermic layer of the drum-head as the result of applications of nitrate is partly absorbed by the deeper structres, acts as a sedative, and promotes the absorption of inflammatory products.

For cases that result from a rheumatic or gouty diathesis, alkalies, with iodid of potassium or salicylate of sodium, should be prescribed, while for cases where the disease results from struma or debility, the use of tonics and cod-liver oil and the employment of hygienic measures should be advised.

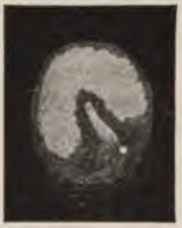

Fig. 160.—Calcareous deposits in the drum-head after middle-ear inflammation (Spalding).

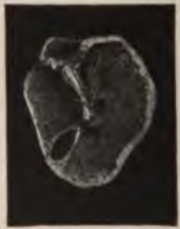

Fig. 161.—Rupture of the antero-inferior half of the drum-head, caused by a box on the ear (after Politzer).

Deposits of chalk (Fig. 160) are usually the result of *long-continued inflammation* of the membrana tympani. Their presence does not indicate that the patient has the gouty diathesis. Only when large do they greatly interfere with the acuteness of hearing by stiffening the drum-head and interfering with its vibrations.

Rupture of the drum-head may result from the direct impact of a foreign body or from the instruments used in extracting a foreign body. Many cases are the result of the sudden compression of the air in the auditory canal produced by falls or blows upon the ear; during war the discharge of large cannon when the patient occupies a position near the mouth of the gun; and when the membrane is diseased, from the use (abuse) of Politzer's air-douche, Siegle's pneumatic speculum (probably the more dangerous instrument), and even from violently blowing the nose. The writer observed a case of this kind in an old lady of about seventy, whose drum-head, aside from the usual senile changes, so far as could be judged by her history and the appearance of the other drum, was normal previous to the accident. Another case was that of a robust young man who attributed his ruptured drum-head to a kiss on his ear.

The drum-head may or may not be ruptured in fractures of the base of the skull. Even in such cases, where there is hemorrhage from the meatus, the blood may come through the roof of the canal and the membrana tympani be intact.

Injury to the drum-head may result from *contrecoup* or be explained by the irradiation theory of Aran.

One of the writer's cases, a lad of about sixteen years, exhibited rupture of both drum-heads as the result of a blow from a baseball received on the left mastoid. It is stated that gunshot wounds of the mastoid may cause rupture of the drum-head apparently as the result of the jar from the impact of the bullet. However, it should be remarked in this connection that a hard blow from the bare fist on the ear is far less likely to produce rupture of the drum-head than a lighter blow from the palm of the hand or a boxing glove, the rupture in the latter case resulting from the condensation of air in the canal.

In rupture of the drum-head resulting from the concussion of cannon shots, bursting shells, etc., there is apparently, if one may judge by the stellate scars seen in cases where the victims have escaped with their lives, actually a tearing out of a portion of the drum-head, usually just below the tip of the malleus.

The *subjective symptoms* are sudden deafness, tinnitus, vertigo, and hemorrhage or a serous discharge from the ear

The *prognosis* as regards the restoration of hearing depends upon the amount of damage done to the other structures of the ear. Most uncomplicated cases recover satisfactorily and speedily, but sometimes purulent inflammation of the middle ear follows as the result of the injury or injudicious treatment.

Treatment.—Cleanse the external auditory canal carefully, so as to remove all blood-clots or other material that might favor the growth of bacteria. Use Politzer's air-douche if necessary to remove blood from the middle ear or little shreds remaining between the edges of the wound to retard union; apply by means of the powder-blower a thin layer of boric acid upon the drum-head, and *let the ear entirely alone* until the healing process is complete, unless pain or the appearance of a purulent discharge renders further interference necessary.

Perforation of the membrana tympani sometimes occurs as the result of ulceration from the dermic surface of the drum-head during an attack of acute myringitis. Under such circumstances the ulcer is usually *central.* The commonest cause, however, of perforation of the membrane is ulceration from within, the result of otitis media purulenta.

Symptoms.—Examinations by means of the concave mirror and speculum usually disclose the presence of the perforation, which, if large, is readily seen. In most cases inflation of the middle ear by the Politzer method produces a characteristic "perforation whistle," heard by means of the auscultation-tube (Fig. 137). Indeed, the perforation whistle is often so loud that it can be heard at a distance of many feet from the patient. If suppuration of the middle ear is present pus will escape through the perforation in the form of bubbles during inflation.

The subjective symptoms vary according to the size and position of the perforation and other diseased conditions of the ear that may be present. A perforation of Shrapnell's *membrane* (Fig. 162), when it has been present for some time, is usually accompanied by considerable hardness of hearing, because purulent inflammation of the attic, the commonest cause of perforation in Shrapnell's membrane, generally involves the articulations of the ossicles and produces lesions which greatly impair the acuteness of hearing. When the perforation is near the center of Shrapnell's membrane the neck of the malleus is exposed, while the perforation through the anterior portion of the drum-head, being directly over the tympanic extremity of the eustachian tube, yields a loud perforation whistle. Rivini has described a perforation or foramen existing in the membrana flaccida as a normal condition. Although such a "foramen" is frequently seen just above the process, it is believed by most aurists to be pathologic.

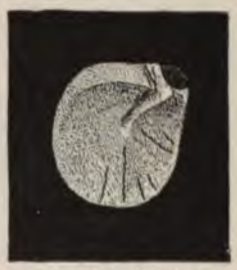

Fig. 162.—Right membrana tympani of a boy of five years, with constant discharge for three years. A perforation about 1.5 mm. in diameter is with difficulty seen above the short process, and intratympanic injections bring away epithelial flakes and masses of fetid secretion. The rest of the membrane is slightly opaque, thickened, and injected (Randall).

When a large perforation in the membrana vibrans involves a considerable part of the malleus handle the tip of this process is usually destroyed by necrosis; should, however, the malleus handle become attached to the promontory, this does not occur. Large perforations may exist in the membrana vibrans without the hearing being greatly impaired, unless the perforation be so placed as to impair the support that the membrana normally gives to the ossicles.

Prognosis.—Perforations of considerable size permit free access of dust, cold, moisture, and other irritants into the tympanic cavity, and predispose the patient to recurring attacks of otitis media. Sometimes the perforation gradually becomes closed by cicatricial material. Indeed, nearly the whole drum-head may be replaced in this manner. But, although the tympanic cavity is by this means protected

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from cold or dust-laden air, *the acuteness of hearing* is generally more or less impaired if the surface of cicatricial tissue be large, and such cicatricial areas break down readily during attacks of acute catarrh of the middle ear.

When seen by reflected light cicatricial areas appear somewhat depressed below the level of the rest of the drumhead, and are sometimes so transparent that the structures within the tympanum are readily discernible through them (Fig. 163). If rarefaction of the air within the auditory canal is produced by Siegle's pneumatic speculum, a cicatrix will be seen to move farther outward than the rest of the membrane. When large and very thin and lax, a "ballooning" of the cicatrix results from inflating the middle ear by means of Politzer's air-douche (Fig. 164).

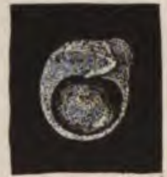

Fig. 163.

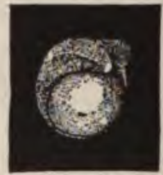

Fig. 164.

Fig. 163.—A large rounded loss of substance of the membrana tympani below reaches up to the tip of the manubrium, which projects slightly into the upper margin. It is closed by a delicate cicatrix applied to the promontory and molded upon its inequalities. The edges of the depression are sharp cut and overhang, so that the area seems an unclosed perforation (Randall).

Fig. 164.—Inflation of the middle ear forces the delicate cicatrix out like a bubble into the meatus, where it seems larger than the opening and hides its edges and the handle of the malleus. In a few minutes the distended sac loses its tension and becomes plicated as it collapses, soon to resume its old position in contact with the inner tympanic wall (Randall).

Treatment.—When all discharge has ceased from the tympanum an effort may be made to close the perforation in order to prevent the irritating effects of dust and cold upon the exposed intratympanic mucous membrane. Closing of the perforation, when small, can be brought about by rubbing its edge every five or six days with a few fibers of absorbent cotton wrapped about the end of an Allen probe and saturated with trichloracetic acid after the application of a 10 per cent. solution of cocain. The acid destroys the epidermal scales or cells which otherwise would extend from the external or dermal surface of the drum-head and prevent the growth of granulations. By keeping the edge of the opening in the drum-head "raw"—that is, free from epidermis—by means of the acid the granulations finally unite in the center of the perforation, which then becomes closed. The same thing can usually be accomplished by the method devised by Blake, which consists in placing a little disk of writing-paper over the perforation. A disk of sufficient size to cover the opening is cut from ordinary writing-paper and is soaked for a few moments in corrosive sublimate solution (1 : 5000). It is then placed on the end of a cotton-tipped Allen probe and carried through a speculum to the drum-head over the perforation. It adheres somewhat firmly to the edge of the perforation because of the sizing or glue which all writing-paper contains.

The paper disk acts as a stimulant and support to the granulations springing from the edge of the perforation, so that they finally unite in the center and the opening is closed. It is somewhat instructive to note from week to week the changing position of the disk of paper. Roughly speaking, the epidermal scales grow from the center of the drum-head toward its periphery, and thence outward along the canal, and hence the disk of paper which was placed over the perforation in the drum-head within a few weeks is seen to be upon the wall of the canal. If, in the meanwhile, the perforation in the drum-head has not closed, another disk of paper should be placed over it, and so on until the perforation has closed.

When a perforation is so large that the support of the tympanic membrane to the ossicles is destroyed, the chain of small bones tends to sag outward by its own weight, and the acuteness of hearing is considerably impaired. If the Toynbee artificial membrana tympani (Fig. 165) be so placed as to give the requisite amount of support when this condition exists, considerable improvement of the acuteness of hearing will result; but little disks of paper, linen, silk, or compressed cotton answer a still better purpose, and a thread may be passed through the center of such a disk to facilitate its removal from the auditory canal. Gruber has contrived an apparatus (Fig. 166) for the introduction of such artificial drum-membranes by the patient himself, who, after a little preliminary instruction, can usually introduce one in a manner to secure the greatest increase of the hearing power. It is astonishing how tolerant the ear sometimes becomes to the presence of such objects, which can often be used for a long time without any deleterious results. It is not a matter of indifference as to the material employed in the manufacture of the artificial drum-heads. Some patients hear best with disks made from one material, some with those made from another.

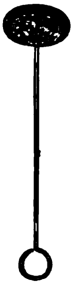

Fig. 165.—Toynbee's artificial drum-head.

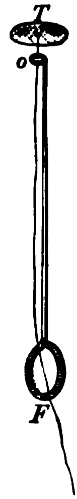

Fig. 166.—Contrivance for introducing artificial drums (Gruber).

When a large cicatrix is present which bulges greatly after inflation—*i. e.*, is very freely movable—the hearing can often be improved greatly by the application of a small quantity of contractile collodion (Formula 78). The collodion is best applied by means of a small camels'-hair brush after the inflation of the tympanum. The application of collodion should not be repeated at too frequent intervals or too much applied at one time, because pain and myringitis may result.

DISEASES OF THE TYMPANUM

Otitis Media Catarrhalis Acuta.—Acute catarrhal inflammation of the middle ear is an acute inflammation of the mucous membrane of the tympanum, eustachian tube, and, sometimes, of the mastoid cells, characterized by increased secretion of serum or mucus, but not of pus. Clinically, cases of acute catarrh of the middle ear are divided into two classes: One in which the attic of the tympanum and mastoid antrum are involved by the diseased process; the other in which the disease is confined to the eustachian tube and atrium of the tympanum.

Etiology.—The disease is in almost all instances the result of exposure to cold. Chronic catarrhal affections of the upper respiratory tract render many individuals susceptible to recurring attacks of inflammation of the middle ear, while in many instances carious teeth have the same effect. Very often pain commencing as a toothache extends to the ear. In many cases the disease is the result of surf-bathing or of diving into water from a considerable height.

In cases where acute catarrh results from diving and surf-bathing the direct impact of water upon the drum-head produces sufficient traumatism to cause the disease. A large auditory meatus, a cicatricial drum-head, or a perforated drum render the middle ear more liable to traumatism while bathing, and such individuals should never dive or bathe in the rough surf without stopping the ears with absorbent cotton saturated with vaselin to exclude the water. All amphibious animals have valves which exclude water from the auditory canal during the time the animal is under water, and hunting dogs taught to dive sooner or later become deaf. However, it is not always the forcible entrance of even cold water into the auditory canal that is responsible for an attack of acute aural catarrh. Not infrequently in surf-bathing a wave will strike a bather in the face at a time when he is swallowing or performing some other function that opens the eustachian tubes, and under such circumstances the water sometimes penetrates as far as the tympanum, and if not speedily removed is capable of causing acute intratympanic inflammation. An accident of this kind once occurred to the writer and was accompanied by a certain amount of vertigo and syncope, and it seems not improbable that some cases of drowning may be the result of the entrance of water into the ears during surf-bathing or swimming in rough water.

Occasionally fluid used as a nose-wash penetrates the eustachian tubes and occasions acute tympanic catarrh or even suppuration, although the wash may be as bland and unirritating to the nasal mucous membrane as the normal salt solution. Bland oils may be thrown into the eustachian tube with impunity, but watery solutions frequently cause mischief. The use of such contrivances for cleansing the nasal mucous membrane as Thudicum's douche, the Bermingham douche, etc., are by no means as safe as an atomizer, and acute catarrh of the middle ear has resulted from simply sniffing normal salt solution into the nose and blowing the nose forcibly immediately afterward, so that some of the fluid reached the tympanum. Should water reach the tympanum during bathing or a watery nose-wash be inadvertently injected into the middle ear while cleansing the nose, Politzer's or Valsalva's method of inflation immediately should be employed sufficiently often to free the middle ear from the fluid.

The exanthematous fevers, and occasionally typhoid and tuberculosis, operations in the posterior portion of the nares, in the postnasal space, and even upon the tonsils occasionally cause acute otitis.

Pathology.—The affection in most cases begins as a catarrh of the pharyngeal orifices of the eustachian tubes, accompanying similar disease of the nose and nasopharynx. If the pharyngeal orifices of the eustachian tubes are inspected by means of the rhinoscope at the beginning of an attack, the mucous membrane of the tube mouths will be found so congested and swollen as to either completely close the tubes or at least greatly interfere with the proper ventilation of the middle ear. Later on the secretions from the tubes are abundant, becoming more consistent in most instances as the disease advances, so that a bulb of thick glue-like mucus may project from the orifices of the eustachian tubes into the pharynx. The mucous follicles are sometimes swollen, giving a granular appearance to the tube lips.

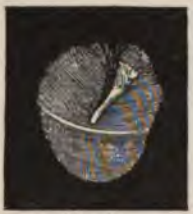

Fig. 167.

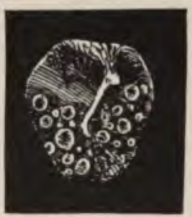

Fig. 168.

Fig. 167.—Collection of fluid exudate in the lower part of the tympanum, marked by a glistening line across the membrane. From the right ear of a young man in the middle of an acute coryza. Cure by politzerization (Politzer).

Fig. 168.—Foamy secretion in the tympanum after inflation, in a case of serous accumulation. From a patient with acute nasopharyngeal catarrh (Politzer).

The appearance of the membrana tympani varies somewhat at the commencement of the disease. Generally it is pinkish in color, as the result of the congestion of the inner or mucous layer, and the manubrial plexus of blood-vessels is congested. Often the membrana is more dull and opaque than it is normally. Often a line as fine as a hair, extending across the drum-head, indicates the upper level of the fluid within the tympanum (Fig. 167). If the fluid within the tympanum is thin and mobile, it will be seen to alter its position with the movements of the patient or during the use of the pneumatic speculum. By inflating the middle ear by the Politzer method the fluid can sometimes be broken into foam and the dim outlines of minute air-bubbles discerned through the drum-head (Fig. 168).

The *bacteria* found in the secretion varies. However, there is practically never a mixed infection. The staphylococcus and the pneumococcus of Friedländer probably are the forms most commonly present.

The *prognosis* under appropriate treatment is favorable. Most cases completely recover. In neglected cases, however, the disease often assumes the purulent form or relapses into the chronic condition.

Symptoms.—Generally, there is pain increased by movements of the jaw, pressure over the tragus, or gently pulling the auricle outward. Hardness of hearing will be greater than in simple myringitis, if, indeed, myringitis ever occurs without the inflammation involving, to a certain extent, the entire mucous membrane of the middle ear. There will be present tinnitus and perhaps vertigo. The entire membrane may be flattened or even bulging as the result of the pressure of fluid within the tympanum. The color of the membrane may be nearly normal in appearance. There may be more or less congestion about the periphery or the region of the malleus handle. In the later stages of the disease, if rupture of the drum-head be delayed, the swelling of the drum-head is so great that the outline of the malleus handle is lost to view and the drum-head is not distinguishable by color from the surrounding red and swollen skin of the canal.

Treatment.—In most cases of acute catarrh of the middle ear, if seen early, it is advisable to prescribe ⅓ gr. of calomel combined with 5 gr. of the bicarbonate of sodium, to be taken every hour for six hours, for the double purpose of securing free evacuation of the bowels and the alterative effects of the calomel, as it has been maintained that small, frequently repeated doses of calomel have the power of controlling inflammation of mucous membranes.

The pain is often relieved by the use of *leeches*. It is customary, in cases where there is severe pain, to apply at least three leeches, one in front of the tragus, one on the mastoid as close to the auricle as possible, and one just beneath the auricle in the angle between the jaw and the mastoid process. These points are selected because they are the positions where the circulation of the middle ear is most readily depleted. The leeches should be the largest procurable and the wounds should be encouraged to bleed for a time after their removal.

A half-century ago leeches were much more freely used in the treatment of acute aural catarrh than at present. Some writers of this period recommend that as many as ten leeches be applied to the margin of the auditory canal in relays; that is, as fast as one leech filled and dropped off a fresh leech was applied as nearly as possible to the same spot. It is certainly true that in order to relieve the pain of acute catarrh of the middle ear or myringitis the blood-letting should be somewhat free and that little relief will follow the use of less than three leeches. The use of leeches in the hyperemic stage of acute otitis media when the pain is severe will not only relieve the pain but also will often cut short the progress of the inflammation. After the use of leeches hot applications should be made to the ear. This can be done by filling the auditory canal with hot water and afterward applying a hot flaxseed poultice over the auricle, but in most cases the pain is more quickly and completely relieved by the instillation of anodynes into the ear and the application of *dry heat.*

The patient may lie with the affected ear upon a hot-water bag or a bag of hot salt, or 1 or more drops of a 4 per cent. solution of cocain be placed within the auditory canal from time to time. In some cases, however, a combination of morphin and atropin seems to act better as an anodyne than cocain. A hypodermic tablet of atropin and morphin may be dissolved in a few drops of warm water and dropped into the ear. It is best to use a certain amount of caution in the use of powerful narcotic poisons within the auditory canal, as cases of poisoning have been reported. It is a safe rule never to drop into the auditory canal a larger amount of atropin or morphin than can safely be administered by the stomach. A 10 per cent. solution of phenol in glycerin may be dropped into the ear and the meatus stopped with absorbent cotton.

It should be borne in mind in using anodynes within the ear that when the mucous membrane of the middle ear is exposed watery solutions are more readily absorbed than oily solutions or ointments, but that the contrary is the case when the drum-head is intact and absorption must take place through the surface of the skin; also that inflamed surfaces, whether of skin or mucous membrane, absorb anodynes much more slowly than when no inflammation is present. A 3 per cent. solution of cocain painted upon the exposed mucous membrane of the middle ear quickly relieves the pain of tympanic neuralgia, and more slowly that of active inflammation, but where the drum-head is intact a 10 per cent. ointment of cocain and lanolin will give greater relief from pain than a watery solution. However, painting the drum-head with equal parts of cocain, menthol, and phenol is better than either solutions or ointments of cocain (Formula 11).

When fluid is present within the tympanum an attempt should be made to evacuate it by the use of the *Politzer air-douche.* The nose and nasopharynx should first be cleansed by the spray from an atomizer containing an alkaline solution and a piece of absorbent cotton, saturated with a 4 per cent. solution of cocain, inserted within each nasal chamber. After contraction of the turbinated bodies has been secured the nasal chambers and the vault of the pharynx should be sprayed with a 4 per cent. solution of antipyrin to maintain the effects of the cocain for several hours and relieve congestion of the pharyngeal lips of the eustachian tubes. The Politzer air-bag should now be filled with the vapor of *menthol*-chloroform and *used with no more force* than is necessar to free the tube and middle ear from mucus. This treatment should be repeated once or twice a day, omitting the use of the cocain and antipyrin if the nasopharyngeal mucous membrane be not sufficiently swollen to require it.

If, notwithstanding antiphlogistic and other measures, there is bulging in the tympanic membrane, with indications that a perforation is likely to occur, it should be *punctured* by a paracentesis needle at the most prominent point of bulging or in the postero-inferior quadrant. This operation is harmless if antiseptic precautions be observed. The canal should be cleansed by wiping it out with a pledget of cotton wrapped about an Allen probe saturated with hydrogen peroxid. It should then be syringed gently with warm corrosive sublimate solution (1 : 2000). After being sterilized, a knife (Fig. 178, 5) should be thrust through the membrane. If the malleus handle is not invisible as the result of swelling, the operator should make the puncture on a level with the tip of the malleus handle midway between it and the periphery of the drum-head, and cut downward as far as possible while the knife is being withdrawn. If this technic is observed it will tend to avoid puncturing the bulb of the jugular vein, which in some cases lies immediately beneath the mucous membrane of the floor of the tympanum, without an intervening lamina of bone. Should the vein accidentally be punctured the hemorrhage for a moment may be quite free, but is readily controlled by packing the canal with iodoform gauze.

Puncturing a normal drum-head after the parts have been cocainized is not a very painful procedure, but when inflamed paracentesis causes severe pain even after the fundus of the canal has been most carefully cocainized (Formula 11). Therefore, if the operation is performed without a general anesthetic, it should be done with the utmost quickness. The thrusting of the knife through the drum-head is sometimes followed by the escape of air with an audible hiss. At other times th of fluid which quickly fills the entire canal, but in some cases there is little fluid secreted for some hours after the operation. The canal in either case should be stopped with a loose plug of sterile iodoform gauze, which should be changed as often as it becomes saturated by secretions.

The relief from pain occurs in some cases within a few moments after the operation. In other cases an hour or more elapses before the pain begins to subside. There are few cases where no relief from pain is afforded by the operation.

Without general anesthesia the simple, straight incision, quickly done, is all that most patients will permit. Under ether the incision may be made to extend around one-third of the posterior periphery, or a large V-shaped flap involving the posterior half of the drum-head may be made. These large incisions afford better drainage, but, as a matter of fact, they close almost as rapidly as smaller incisions. When the attic is inflamed and there are symptoms of commencing mastoiditis, a thrust upward through Shrapnell's membrane posterior to the short process sometimes affords the relief from pain that paracentesis of the membrana tensor failed to secure. As the knife is withdrawn its point should be kept in contact with the bone of the roof of the canal for about ½ inch in order to cut periosteum of this region.

Otitis Media Catarrhalis Subacuta.—The name is sometimes applied to that stage of catarrhal disease intermediate between the acute and chronic forms. However, by *subacute* catarrh of the middle ear or simple acute otitis media is generally meant an inflammation less severe in type than the acute. Pain is neither severe nor long continued and the patient is deaf only for a short time. The attacks occur at frequent intervals. Upon examination the membrana tympani is found pinkish in color and is decidedly opaque and lacks its usual luster. The cone of light is either smaller than normal or has entirely disappeared. As the drum-head never ruptures, permitting an examination of exudates, the kind of bacteria present, if any, is a matter of conjecture. It is doubtful if any be present.

Etiology.—The disease is commonest in children as the result of disease of the nose and pharynx, hypertrophied pharyngeal tonsil being an exceedingly common cause of the affection. Bad nutrition, carious teeth, and frequent attacks of coryza are common predisposing causes.

The *treatment* should be directed toward improving the patient's general health and removing any predisposing cause of the affection. If the teeth are carious they should receive the attention of a skilful dentist, while the efforts of the aurist should be carefully directed toward the removal of any morbid condition existing in the nose and nasopharynx, because experience has amply demonstrated that in most cases attacks of subacute aural catarrh cease to recur as soon as a cure is brought about of the concomitant nasopharyngeal disease. The knowledge of this fact, however, is not an excuse for neglecting local treatment of the ears while the nose and nasopharynx are receiving attention.

Adenoid growths and hypertrophied faucial tonsils should receive appropriate treatment in the manner already described.

At each biweekly or triweekly visit of the patient the nose and nasopharynx should be cleansed by means of an atomizer filled with an alkaline solution, after which the ears should be carefully inflated by means of Politzer's air-bag. If the inflammation of the middle ear is not too active "massage" should be applied to the drum-head and the ossicles by the aid of Siegle's pneumatic speculum, after which there should be made to the interior of the nose and nasopharynx an application of an iodin solution (Formula 111) in the case of children, or an astringent solution (Formulas 112, 113) in the case of adults, and the parts covered with albolene by means of the spray from an atomizer.

The *hygienic surroundings* of the patient should receive careful attention and tonics and cod-liver oil prescribed in suitable cases. In children catarrhal inflammation is generally of an adenoid character; that is, the lymphatic elements of the mucous membrane bear the brunt of the disease, so that children and young adults do well upon iodin compounds applied locally and given internally. Syrup of the iodid of iron should be prescribed for internal use, with or without cod-liver oil, as the circumstances of the case require, while hypertrophy of the lymphatic glands underneath the skin of the neck should be treated by inunctions at bedtime of a 10 per cent. ointment of ichthyol in lanolin. The ointment should be rubbed lightly into the skin and the bedclothing protected by waxed paper and a bandage about the child's neck.

Catarrh in adults is often characterized by inflammation of the mucous glands and interstitial elements of the mucous membrane; and it is in such cases that sedative applications and astringents are most useful. The vapors of various volatile substances are sometimes applied to the middle ear by means of Politzer's air-bag. The most useful of these substances are iodin, menthol, and chloroform. Glass-stoppered bottles, each partly filled with one of these drugs (Formulas 80–83), should be at hand in the office, so that the Politzer air-bag can readily be filled with the vapor of the drug which it is desired to use by inserting the nose-piece of the instrument within the neck of the bottle. The vapor can then be made to reach the mucous membrane of the middle ear by Politzer's method or by the employment of a eustachian catheter. The vapor of iodin, when thrown into the middle ear, acts as an alterative and gentle stimulant, that of menthol as a sedative, while chloroform vapor is probably simply a stimulant. It is generally easier to inflate the middle ear when the air-bag is filled with chloroform vapor than when it contains simply air.

Otitis Media Catarrhalis Chronica.—Chronic catarrh of the middle ear is a chronic non-suppurative inflammation f *the mucous* membrane and submucous tissues of the middle ear, producing deafness, tinnitus, and sometimes vertigo and other symptoms of altered auditory functions.

Pathology.—There are two forms of the disease, the adhesive and the interstitial, where lime deposits occur in the vessels and osteomyelitic changes take place in the ossicles and labyrinthine capsule, causing ankylosis and closure of the fenestra. Gradual progressive changes take place in the mucous membrane and submucous tissues of the middle ear similar in character to those that occur in the mucous membranes of other parts of the body. There is first hyperemia and hypertrophy, then hyperplasia, and finally sclerosis.

The first stage of the disease is a dilatation and engorgement of the capillaries, with an exudation of serum and round cells, both from the surface of the mucous membrane and also into its substance. The capillaries are engorged, the mucous membrane is swollen and edematous; an exudate is constantly moistening its surface. The inflammatory exudate within the substance of the mucous membrane contains round cells, which proliferate and increase in size by a process of elongation, so that they are finally converted into newly formed connective tissue, sometimes causing cords, bands, contractions, and calcifications similar in appearance to cicatricial tissue following suppuration.

During the earlier stages of the disease the thickened mucous membrane is redder and rougher than normal, soft, and easily depressed with the end of a probe. As a result, however, of the gradual increase of connective tissue and the absorption of the more fluid parts of the exudate the mucous membrane, while still much thicker than normal, is pale and quite smooth. This condition represents a stage intermediate between hypertrophy and atrophy of the tympanic mucous membrane. It is hyperplasia of the mucous membrane.

As a mechanical result of the contraction of the newly formed connective tissue the glandular elements of the mucous membrane disappear and it finally resembles scar *tissue.* The mucous membrane becomes smooth, thin, and secretes but little fluid. In some cases atrophy or sclerosis of the mucous membrane of the tympanum rapidly occurs without any pre-existing stages of hypertrophy. Such cases are often the result of syphilis or they follow purulent inflammation of the mucous membrane with or without perforation of the drum-head.

It should not be supposed that the changes in structure above described progress evenly throughout the entire mucous membrane. Often depressed, scar-like spots of atrophy are seen in the midst of the rough, succulent, and swollen mucous membrane characteristic of the hypertrophic stage of chronic aural catarrh.

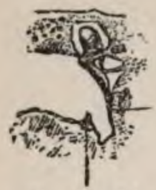

Fig. 169.—Schematic section of a case of attachment of the manubrium to the promontory (Politzer).

Not only are the mucous and submucous structures involved in long-continued catarrh of the middle ear, but also the bony structures. The cavity of the tympanum becomes more roomy, and as a result of interference with the nutrition of the parts, chalk deposits take place in the deeper layers of the mucous membrane, in the membrana tympani, the membrane of the round and oval windows, and in the ligaments and cartilages connected with the ossicles. The ossicles frequently become ankylosed, and adhesions form which bind them to one another or to the surrounding bony walls of the tympanum, while bands of newly formed connective tissue may extend across the tympanum or mastoid antrum. The membrana tympani and manubrium occasionally become adherent to the promontory (Fig. 169), sometimes as the result of newly formed adhesions, or from the degeneration of bands of mucous membrane, which normally exist in the embryo and frequently persist during life.

Ordinarily, catarrh of the middle ear is but part of a diseased process involving the nose, throat, eustachian tubes, *and mastoid* cells. The stage of the disease and the degree of inflammation may vary in the different parts affected. In most instances the eustachian tube is the first part of the middle ear affected, as the disease progresses by continuity of structure from the nose and pharynx to the tube. Stenosis of the tube, from swelling of the lining mucous membrane or accumulation of secretions, interferes with the proper ventilation of the tympanum, thus producing a partial vacuum within the cavity, a constant *dry cupping*, as it were, of the tympanic mucous membrane, with consequent engorgement of its capillaries.

Otosclerosis, rarefying osteitis, spongification or hyperostosis of the bony capsule of the labyrinth, is a hyperplasia of the bony capsule resulting in the metaplastic transformation of cartilage into bone and bony outgrowths or hyperostoses. In macerated specimens the newly formed bone is whiter and more porous than that surrounding it. The disease is most noticeable at the fenestra, which gradually becomes narrowed until at the oral window there is complete bony ankylosis of the stapes. The deafness is then great, but the drum-head may be of normal luster and position, a red reflex indicating the congestion of the mucous membrane of the capsular or inner wall of the tympanum.

Etiology.—It is generally the result of an extension of a similar disease of the nasopharynx through the eustachian tubes. The chronic condition may become established after repeated attacks of acute catarrhal inflammation of the middle ear. Carious teeth cause chronic catarrh of the middle ear as the result of reflex irritation. The similarity of the pathology of middle-ear catarrh to rheumatism of the joints was pointed out by Toynbee and some of the other aurists of a half-century or more ago. Recently O'Malley has endeavored to demonstrate that chronic adhesive paracusis in the middle ear is rheumatoid arthritis of the organ of hearing and otosclerosis is osteoarthritis of the stapedial articulation and labyrinth capsule. Those constantly exposed to loud noises, as the result of working at certain trades, like boiler-making, are especially prone to lose their hearing. Syphilis, scrofula, and any condition of lowered vitality, inherited or acquired, may be enumerated as predisposing causes of the disease. Some observers maintain that otosclerosis is simply the result of a primary inflammation of the middle ear. However, the majority seem to be of the opinion that the disease of the capsule is *primary* and that concomitant pathologic conditions of the middle ear are secondary or coincident. Heredity is an important factor; but when the tendency to otosclerosis exists, intratympanic inflammations greatly accelerate the progress of the disease, as in chronic suppuration following scarlet fever, when the slowly increasing deafness is not the result of true otosclerosis.

Subjective Symptoms.—There is gradually increasing deafness. The decrease in the power of hearing is, however, by no means uniform. Successive attacks of subacute exacerbations of the catarrhal inflammation produce comparatively great impairment of the hearing power, which, in turn, somewhat improves. In this manner the disease progresses, the hearing being better or worse from week to week, but becoming gradually more impaired from year to year. Patients hear better during clear, dry weather than on rainy or damp days. This is not the result of any change in the acuteness of hearing, but simply due to the fact that dry, cold air is a better conductor of sound than moist air. The acuteness of hearing may not decrease to the same degree for all sounds. Many patients hear a watch tick at almost the normal distance, but hear spoken words very indistinctly. In other cases the impairment of hearing is most manifest for musical tones, like those emitted by a tuning-fork. A common remark from some patients is that they hear the sound of the voice distinctly, but are unable to distinguish the words spoken. This *slow* hearing is probably due to the sluggish action of the tensor tympani and stapedius muscles, *whose action* changes the tension of the ossicular chain, so that under normal conditions it is instantly tuned to the pitch of each sound. Hence most deaf persons hear words best not when spoken in a loud voice, but when spoken slowly and distinctly.

A sense of fulness and discomfort within the ear and certain modifications of the hearing are not uncommon during the course of chronic aural catarrh, the commonest modification of the hearing power being *paracusis willisii*, or increased hearing power in the midst of noise, as, for example, when the patient is on a moving railroad train. This phenomenon has been ascribed to great rigidity of the ossicles and contraction of the tensor tympani muscle, and it is of sinister import as to the ultimate effects of treatment. The presence of the condition may be demonstrated by placing a large fork of 32 vibrations per second on the forehead. If while the fork is vibrating a watch is heard more distinctly, paracusis willisii is present.

Dysacousma or *dysesthesia acoustica* is a condition in which loud noises or even those of moderate intensity cause painful sensations. When the patient hears his own voice, somewhat altered in character and pitch, as if it came from a distance or through the tissues of his head, the symptom is called *autophony*. *Paracusis duplicata* and *paracusis diplacusis* are names given to the phenomenon in which the patient hears sounds as if repeated twice, the second sound seeming somewhat like an echo of the first. Probably in most cases of chronic catarrhal deafness sounds are not only altered in intensity but also in pitch and character as well. It is difficult, however, to observe any subjective alteration in the character or pitch of muscial notes except in the case of musicians who are deaf only in one ear. In such cases not infrequently the note of a tuning-fork will seem to be of a different character and pitch when sounded before the deaf ear from that emitted by the same fork when sounded before the patient's normal ear. When subjective alteration of the character and pitch of sounds is sufficiently manifest to be a source of discomfort to the patient, the name *pseudacousma*, or false hearing, is applied.

Tinnitus, subjective ringing or hissing sounds heard in the ear, is a symptom of aural catarrh rivaling in importance even progressive hardness of hearing. It is sometimes the only symptom of which the patient complains, the fact being that, although he is somewhat deaf, yet his hearing is still sufficiently acute for the ordinary purposes of his life, and occasions no discomfort. Some such patients are actually surprised when tests of their hearing demonstrate that it is defective. This is especially the case when only one ear is diseased. Tinnitus is usually worse at night and it may not be present at all in some cases during the daytime. It is subject to great variations in degree in some cases of aural catarrh, disappearing for months at a time and then reappearing. Usually tinnitus disappears in the later stages of the disease. Involvement of the labyrinth may increase or decrease tinnitus, according as the nerve-fibers are simply irritated or destroyed.

The *head noises* complained of by patients are almost as numerous as the individuals affected, but may be divided into three classes—the pulsating, the continuous, and sounds more or less elaborated, like the ringing of bells, music, and words and sentences uttered with more or less distinctness—the latter class only being referred to a point outside the head are the result of disease of the ear acting on an easily excitable brain. Some of the cases are at least on the border-line of insanity, and not only hear voices but see visions. Benefit sometimes results from treating the concomitant aural disease.

Inflammation of the external auditory canal, foreign bodies, impacted cerumen, and polypi are capable of producing tinnitus, and, in rare cases, vertigo, nausea, cough, or even epileptiform convulsions.

Sometimes the result of anemia or, more rarely, of an aneurysm, pulsating tinnitus ordinarily indicates arterial congestion of the middle ear or of the labyrinth. The differential diagnosis between the two conditions can be made with a limited amount of accuracy by pressure upon the carotids or on the vertebral arteries at the point where they cross the atlas, because a branch of the carotid supplies the tympanum and a branch of the vertebral supplies the labyrinth.

Vertigo is a symptom of chronic otitis media, usually transitory in character. In all cases it is probable that aural vertigo is due to some condition within the semicircular canals of the labyrinth; generally it is an alteration of the normal interlabyrinthine pressure produced by increased tension exerted through the fenestræ or by a contracted tensor tympani through a rigid chain of ankylosed ossicles. Impacted teeth, visual disturbances, cardiovascular affections, gastro-alimentary disorders, poisoning by quinin, alcohol, etc., may produce such an action on the labyrinth as to cause vertigo. However, only when *structural changes* have occurred to the tissues within the labyrinth should the name "Ménière's disease" be given to a condition which otherwise is simply aural vertigo and one of the symptoms of disease of the middle ear.

Although the condition of the membrana is not invariably an index of the condition of the tympanum, yet certain inferences may be drawn from its appearance that are the more valuable because it is the only visible part of the tympanum. The luster and color of the drum-head may be nearly normal, both at the commencement of chronic otitis media and also at a stage of the disease when the atrophic changes are far advanced. In the latter condition, however, a red reflex from the promontory indicates inflammation of the inner tympanic wall probably involving the labyrinthine capsule —*otosclerosis*. During the hypertrophic period of catarrh of the middle ear evidences of involvement of the drum-head are usually not lacking. There may be patches of opacity or the whole drum-head may have lost its translucency and appear white, rough, thick, and opaque. The light spot may not occupy its normal position as the result of an indrawing of the drum-head or it may be smaller than normal because of a roughening of its surface, and from the same cause or from local depressions it may divide into two or more maculæ. If the drum-head is greatly depressed a light spot sometimes appears over the short process, which projects outward through the tightly drawn tissues like the knuckle of a finger. The handle of the malleus is, under such circumstances, foreshortened, appears shorter than normal, or it may be drawn so far backward as to lie almost horizontal beneath the posterior fold. Spaces abnormally white and opaque may be interspersed upon the same membrane with spots abnormally thin and translucent.

It is always a matter of considerable importance to determine the resiliency and tension of the membrane. This may be effected by observing the movements of the drum through Siegle's pneumatic speculum (Fig. 23). When the air within the canal is rarefied by means of this instrument a drum-head so far indrawn that it rests upon the promontory may be sucked outward until it appears like a balloon, a groove upon its convex surface indicating the position of the malleus handle. Sometimes isolated areas upon the drum-head will exhibit abnormal mobility. Ordinarily such spots are cicatrices formed by the closure of a perforation. This appearance may be produced, however, by localized atrophy.

Deep localized depressions are found at spots where adhesions have occurred between the membrane and promontory (Figs. 170, 171), such spots appearing much darker than the surrounding area. Sharply defined deposits of chalk, more especially in the posterior half of the drum-head, are not uncommonly seen (Fig. 160).

The *patency of the eustachian tube* is tested by the Politzer method of inflation. During the earlier stages of the disease the tubes are usually somewhat obstructed, but during the *later* stage they are abnormally patulous. A favorable prognosis may be given the patient if after inflation of the tympanum the hearing is greatly improved. Under such circumstances the impairment of hearing is largely due to obstruction of the eustachian tubes—a condition amenable to treatment. If, however, the tympanum is easily inflated by the Politzer method and there results considerable outward movement of the membrana tympani without much improvement in the hearing, the prospect of speedily improving acuteness of hearing is not encouraging.

In hyperemic and hypertrophic stages of catarrhal deafness hearing for the voice is usually proportionately worse than for the watch and tuning-fork; in the atrophic form of the disease, however, the reverse is usually the case. If only one ear be affected a vibrating tuning-fork placed on the vertex, forehead, or teeth (Weber's method) is heard best in the affected ear so long as the functions of the auditory nerve and labyrinth are unimpaired. Before involvement of the receptive apparatus has occurred a vibrating tuning-fork with its handle upon the mastoid will be heard better than when its vibrating tines are held in front of the ear (Rinné negative). Great deafness, patulous eustachian tube, a red reflex though a normal drum-head, and "Bezold's triad," viz., raised lower tone limit, lengthened bone conduction, and negative Rinné indicate otosclerosis.

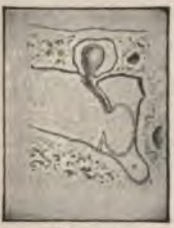

Fig. 170.

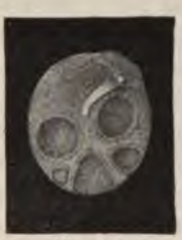

Fig. 171.

Residua of middle-ear suppuration.

Fig. 170.—Transverse section (schematic), showing adhesions of drum-head to promontory.

Fig. 171.—Front view, showing old cicatricial center lesions (Spalding).

The *prognosis* is only favorable in cases in which the disease has not progressed beyond the early hypertrophic stage of the disease. Fluid exudates will be absorbed as the result of treatment and simple inflammation of the mucous membrane of the tympanum will disappear. The prognosis is all the more favorable if the disease is the result of pathologic conditions within the nose or nasopharynx, because in such cases, when the nose and throat are restored to a nearly normal condition, chronic aural catarrh of recent origin usually subsides as the result of appropriate local treatment. The progress of the disease can in most instances be delayed, but when new connective tissue has formed, it remains, and atrophied parts cannot be regenerated. The prognosis is generally hopeless, so far as improvement of the hearing is concerned, in cases in which the labyrinth is seriously involved. However, this may be said for the comfort of those to whom an unfavorable prognosis is given: Chronic middle-ear catarrh is, to a considerable extent, a self-limited disease that progresses irregularly and with greater or less rapidity to a certain degree of deafness, after which the progress is slow. None become completely deaf.

Treatment.—An effort should be made to improve the hygienic surroundings of the patient and to so improve his general health as to render him less liable to contract colds. The nose and throat, if necessary, should receive appropriate treatment. Hypertrophies, ecchondroses, and exostoses of the nasal chambers and adenoid vegetations in the pharyngeal vault should be removed and cicatricial bands broken down; hypertrophied faucial tonsils should be reduced to their normal dimensions. While the immediate effect of any measure to secure free nasal respiration may not be apparent in improved hearing, the freedom from frequent stenosis of the nares from colds and consequent irritation of the middle ear will, after a month or two, scarcely fail to attract the patient's attention.

Triweekly or even daily inflation of the eustachian tubes is of great importance. For this purpose Politzer's method, when possible, should be employed in hypertrophic cases. In atrophic cases, however, the irritation produced by the introduction of the eustachian catheter is sometimes of marked benefit. Either simple air or air saturated with the vapor of chloroform, iodin, menthol, or turpentine may be used for producing the inflation (Formulas 80–83).

In cases where the labyrinth is involved, Politzer's method of inflation should be used with extreme gentleness if at all. Ordinarily in atrophic cases the eustachian tubes are widely dilated, and the violent use of Politzer's bag causes a most unpleasant sensation to the patient and an immediate decrease in the hearing power, which gradually grows worse from repetition of the treatment.

In cases of otosclerosis phosphorus in $\frac{1}{200}$-gr. doses three times a day for six months of the year is sometimes beneficial. Politzer advises a course of potassium iodid.

Many cases not too far advanced are greatly benefited by a spray of menthol and camphor in fluid albolene (Formula 125), thrown into the middle ear by means of the eustachian catheter and atomizer. After introducing the catheter and applying the auscultation-tube the patulency of the eustachian tube is tested by means of Politzer's bag (Fig. 138). The nozzle of an atomizer is then inserted within the proximal extremity of the catheter. In cases where the eustachian tube is widely dilated the spray from the atomizer will be heard to enter the tympanum; but in most instances it enters the eustachian tube for but a short distance, except during the act of swallowing by the patient. After a time a certain amount of oil condenses in the catheter and eustachian tube. This should be blown as far up the tube as possible by means of Politzer's bag.

For the same purpose Politzer advises 5 to 8 drops of a solution of sodium bicarbonate (10 gr. to 1 dram of water), to which has been added 8 drops of glycerin; 5 to 6 drops of a 2 per cent. solution of pilocarpin has been employed with advantage. Perspiration and salivation occur while the patient is still in the office and the treatment is unadvisable for those with weak hearts.

Thiosinamin, 6 to 10 gr., in divided doses per day, or 12 to 18 minims of a 10 per cent. solution three times a week, is said to promote absorption of deposits.

Local treatment should not be continued after improvement in the acuteness of hearing ceases. All possible improvement can be secured usually in from three to six weeks by local treatment every other day. However, if symptoms of relapse appear after a time, renewed local treatment will be necessary.

Stricture of the eustachian tube may be dilated by carefully passing a eustachian bougie through the stricture, but the use of this instrument requires the utmost care to avoid a disastrous or even fatal result from emphysema as the result of tearing the tubal mucous membrane.

The *diagnosis* of stricture of the tube is made by means of the catheter and auscultation-tube. Air is not heard to enter the tympanum. This may be due to simple swelling of the mucous membrane, transient in character, which can be made to yield by blowing a drop or two of a 4 per cent. cocain solution from the catheter into the tube, followed in a few moments by an oily spray of adrenalin (1 : 1000) through the catheter. If after a few moments air is heard to enter the middle ear through the catheter, the eustachian tube may be sprayed with menthol-camphor-albolene in the manner previously described.

If, however, these measures fail to secure the entrance of air into the middle ear, employment of the eustachian bougie is a justifiable procedure. As long as no stricture is encountered the bougie can be passed somewhat readily from the catheter along the eustachian tube. If resistance is felt, it may be due to the normal narrowing of the tube at the isthmus. The bougie should be marked in millimeters in such a manner that it is possible, by referring to these markings, to know the exact position of the distal end of the bougie and when it has entered the isthmus or junction of the cartilaginous and bony portions of the tube. It is not desirable to push the bougie much beyond this portion of the tube.

If a stricture is encountered a resistance will be felt to the onward passage of the bougie, which usually can be overcome by gentle pressure for a few moments. After the bougie has passed beyond the stricture it should be allowed to remain in position for a few minutes and then withdrawn. When it is impossible to pass a bougie of hard rubber or whalebone, an attempt may be made to destroy the stricture by electrolysis. Duel has devised gold bougies of three sizes for this purpose, one of which is passed through a rubber-covered catheter into the tube until the stricture is encountered. The sponge from the positive pole of the battery is applied to the patient's neck and the negative pole is connected with a bougie. The current is then gently turned on to a strength not exceeding 3 to 5 milliamperes. The bougie is held firmly in contact with the stricture and after a moment is felt to pass through it.

The *treatment* causes no pain and may be repeated at intervals of once a week. It is safer not to attempt to inflate the middle ear immediately after the passage of a bougie. The patient, however, may return the next day to have his ears inflated.

The bougie may be passed into the eustachian tube after the passage has been oiled with the spray from an atomizer containing albolene, or a few drops of a 50 per cent. solution of argyrol may be dropped into the catheter before passing a hard-rubber bougie through it into the tube. Dixon has devised a set of five metal applicators to be used without a catheter by the aid of Holmes' nasopharyngoscope introduced through the other nostril. The distal end of the applicator is bent at an angle of 45 degrees at distances of ½ inch (No. 5) to 1½ inches (No. 1). Dilatation is made by cotton wrapped about the end of the applicator and soaked in 5 per cent. cocain adrenalin.

Massage of the Middle Ear.—Next in importance to inflation of the middle ear is systemic massage by means of Siegle's pneumatic speculum (Fig. 23) or some other massage instrument by means of which the air within the auditory canal can alternately be condensed and rarefied, and motion be thus imparted to the membrana tympani and ossicles. This procedure is almost invariably followed by an amelioration of tinnitus if this be present, and it probably constitutes the most satisfactory treatment for this annoying symptom, although freezing the tissues over the mastoid process by means of the spray from a tube of ethyl chlorid and exhausting the air within the auditory canal by a plug of oiled absorbent cotton sometimes yield good results.

Systematic massage of the middle ear by means of the patient's finger-tips is of the greatest value, for while it is somewhat dangerous to instruct an individual to inflate his middle ear by Valsalva's method, as its frequent use is liable to be followed by atrophy of the drum-head and increased deafness, automassage with the finger-tips is entirely harmless and may be used for the relief of tinnitus whenever it becomes annoying. The forefinger should be slightly moistened and slipped into the meatus with the nail posterior. With rapid piston-like movements of the finger-tip inward and outward a patient can easily exercise alternations of pressure and rarefaction of the air within the auditory canal, and hence massage the intratympanum almost as thoroughly as if a pneumatic speculum were used. He may be instructed to employ the method several times a day with increasing relief of tinnitus in many instances and, generally, improvement of the acuteness of hearing. It is seldom that the method fails to afford at least temporary relief from the feeling of fulness or pressure within the ear.

Phonomassage, by means of sounds conveyed to the ear through rubber tubes from various musical instruments or similar contrivances, has been employed in the treatment of catarrhal deafness and tinnitus. If the ears of an individual with catarrhal deafness be subjected for a length of time to musical tones of about the same pitch as the tinnitus from which he suffers, the subjective noises will either entirely disappear or be greatly alleviated, probably as the result of fatigue of the portion of the internal ear adapted to the perception of sounds of that pitch. This method of treatment has been largely abandoned in favor of more rational methods.

Pneumomassage with electromagnetic and other machines, capable of producing rapid alternate rarefaction and condensation of the air in the auditory canal, is undoubtedly of benefit in a large proportion of chronic middle-ear catarrhs, but is probably in no way superior to massage with the pneumatic speculum or the tip of the forefinger. The same remark also applies to direct massage of the chain of ossicles by means of Lucca's pressure probe, which is a spring probe, the cup-shaped end of which fits over the short process of the malleus to prevent slipping; and also to the so-called "internal massage," where short sharp puffs of compressed air from an air-receiver are, by means of an "automatic cut-off" rapidly worked with the tip of the thumb, thrown through a catheter into the eustachian tube.

The wedging of a little ball of absorbent cotton into the space above the short process of the malleus where its weight and pressure serve constantly to push outward the malleus handle and the long process of the incus, thus diminishing pressure on the stapes, in a certain number of cases will afford efficient aid in the treatment of tinnitus and hardness of hearing. The little mass of cotton should be moistened with a suitable antiseptic solution, so that it can be molded to the parts when inserted above the malleus handle, and may be worn for several weeks at a time with benefit in certain cases. It is not readily dislodged from its position by massage either with the pneumatic speculum or the finger-tip, and sometimes gives immediate and ultimately permanent relief from tinnitus.

Tension of the transmitting apparatus of the middle ear may also be decreased by operative procedures, such as repeated paracentesis of the drum-head, tenotomy of the tensor tympani and stapedius, or removal of the membrana tympani and one or more of the ossicles.

Tinnitus is not always the result of diseases of the ear, but rather is a reflex phenomenon due to the irritation of some correlated region—the nose, teeth, or, more frequently, the digestive tract. Just as acute dyspepsia is ordinarily accompanied by vertigo, so the more chronic ailments of the digestive tract sometimes occasion a tinnitus the cause of which is little suspected. The manner in which disease of the digestive tract, teeth, or nose produces tinnitus is through the nervous connection, more or less direct, of those organs with the inferior cervical sympathetic ganglion, which supplies the nervi vasorum to the occipital artery and its branch, the internal auricular. Irritation of the inferior cervical sympathetic ganglion would cause tinnitus as the result of dilation of the arterioles of the cochlea, which, at first pulsating, would afterward become constant in character as the result of trophic changes resulting from increased blood-supply. Quinin, the salicylates, and certain other drugs are capable of producing tinnitus, either as the result of aural hyperemia or by their toxic action upon the internal ear. There is also reason to suppose that in lithemia the products of indigestion exert a similar action in the production of tinnitus. It is, therefore, in cases where dyspepsia and lithemia have done their share in the production of tinnitus that acids, including hydrobromic acid, are especially useful in controlling this annoying symptom. Proper regulation of the diet and regular exercise in the open air and sunlight will, in cases where there is neither disease of the ear, nose, or teeth to account for tinnitus, generally result in a disappearance of the head noises.

The faint pulsating tinnitus due to anemia is diminished by the patient's lying down, and in many instances can be permanently cured by hygienic measures and suitable tonics, among which the well-known pil. sumbul comp. is especially useful. Pulsating tinnitus due to congestion, on the other hand, may be alleviated by the bromids, of which, for the reason stated above, dilute hydrobromic acid, in doses of from 15 to 60 drops three times a day, is probably the best.

The earlier stage of chronic catarrh of the middle ear is ordinarily accompanied by tinnitus, generally constant in character. Later on, as deafness becomes profound, tinnitus often disappears as the result of diminished sensibility of the internal ear. Tinnitus due to middle-ear catarrh is sometimes alleviated by large doses of the bromids; but better results can be obtained in a limited number of cases by the patient taking after meals, for a few weeks, a pill containing $\frac{1}{4}$ gr. of nitrate of silver, $\frac{1}{3}$ gr. of extract of hyoscyamus, and $\frac{1}{30}$ gr. of strychnin.

Otitis Media Suppurativa Acuta.—Acute purulent inflammation of the middle ear is an acute purulent inflammation of the mucous membrane of the tympanum, and usually also of that of the eustachian tube and mastoid cells.

Pathology.—The tympanic mucous membrane is of a bright red color, much swollen, and devoid of its epithelium. There is cellular and serous infiltration of its connective-tissue layer and much exudation of mucopus or pus from its surface. Perforation of the membrana tympani occurs in the majority of cases, the pus being then discharged through the perforation into the auditory meatus; occasionally the discharge is tinged with blood.

Etiology.—Generally the disease is the result of a cold or of traumatism, or it may occur as a complication during diphtheria, scarlatina, small-pox, measles, typhoid fever, syphilis, or tuberculosis. Purulent inflammation of the middle ear is very common in children. Carious teeth and nasopharyngeal disease are predisposing causes of the affection. Suppuration presupposes bacterial infection, which probably takes place in most instances by way of the pharynx and eustachian tube. It is a general rule that the infection at first at least is monobacterial, but that after the membrane is ruptured polybacterial infection commonly occurs from the canal. Efforts should, of course, be directed to prevent if possible this mixed infection. The micro-organisms most commonly found in otorrheal pus are Streptococcus pyogenes, pneumococcus, Staphylcoccus aureus and albus, Friedländer's bacillus, typhoid, and tubercle bacilli. Of the monobacterial infections, that of the streptococcus is most likely to run a severe course, often ending in severe mastoid complications.

Symptoms.—An attack is ushered in by pain in the ear, shooting over the side of the head. Sometimes the pain originates in a diseased tooth and extends to the ear. Chilly sensations and fever are sometimes present, the temperature reaching as high as 102° or 103° F. The ear feels full and there are tinnitus and deafness, the pressure of confined pus upon the secondary membrane sometimes interfering with the functions of the labyrinth. When perforation takes place there occurs a rapid alleviation of the pain and tinnitus.

The appearance of the drum-head is that of acute myringitis. At the end of a few hours to several days or even weeks from the beginning of the attack a bulging at some point upon the drum-head indicates the position where the pus will burrow its way through the membrana. When, however, the attic and mastoid antrum contain pus which cannot readily drain into the atrium because of swelling of the mucous membrane about the ossicles, this pus will sometimes burrow underneath the skin of the auditory canal and find an exit either at some point within the canal or behind the auricle. Those cases in which no perforation occurs run a tedious course and some permanent impairment of the hearing usually ensues. The duration of the disease from the occurrence of a perforation to its closure is very variable. In cases where the perforation occurs early, it may remain open only for a few days. Three or four weeks are ordinarily required for the closure of a small perforation.

If the perforation is large it will probably remain open long after suppuration has ceased, to finally close by cicatricial material destitute of all fibers of the membrana propria, and will bulge inward and outward with the varying intratympanic pressure.

Extensive destruction of the structures of the middle ear sometimes occurs during acute otitis media. This is especially apt to take place when the disease appears as a complication of scarlatina, variola, or diphtheria. The whole of the drum-membrane and all of the ossicles may come away within a few days from the onset of the middle-ear disease as an enormous slough. In other cases, ulceration, starting from the perforation, proceeds more slowly, but it accomplishes equally disastrous results. Inflammation of the mastoid is occasionally a serious complication of acute otitis media, and the labyrinth sometimes participates in the purulent inflammation of the tympanic cavity, the ultimate result in such cases being intracranial complications, often fatal, unless the labyrinth is opened and efficient drainage secured.

Infants affected by acute suppuration cry constantly, turning their heads restlessly from side to side, placing the hand frequently upon the affected ear. High temperature, reaching 103° or 104° F., is usually present and convulsions sometimes occur. The infant sleeps only when completely exhausted or under the influence of opiates. Upon inspection the drum-head is often found enormously swollen, projecting into the canal like a polypus, for which it has been mistaken. Sleeplessness, high temperature, and restlessness quickly disappear after evacuation of the pus.

The *prognosis* of acute purulent inflammation of the middle ear, when it occurs in an otherwise healthy individual, is usually favorable, but the severity of the attack depends largely on the variety of bacteria causing the infection and their virulence. However, the disease frequently assumes the chronic form, and in tuberculous individuals this is the usual outcome of the affection.

Treatment.—In the early stages of the disease, leeches, hot applications, and the other measures already specified as useful for the relief of pain in catarrhal inflammation of the middle ear. Paracentesis of the membrane should be done as soon as bulging occurs. The cut should be 2 or 3 millimeters long and should be made through the point at which the bulging occurs or at the so-called point of election in the posterior quadrant of the membrana tympani, midway between the malleus handle and the periphery (see p. 409). When there is considerable swelling of the upper posterior part of the auditory canal, indicating the presence of pus beneath the skin of this region, the thrust should be through Shrapnell's membrane, and the knife be so withdrawn that its point will cut through the swollen tissues at the upper posterior portion of the canal to the bone, in order to secure free drainage.

After incision of the drum-membrane or when rupture has occurred spontaneously the major part of the pus within the auditory canal should daily be removed by means of absorbent cotton wrapped about the end of a probe, and the pus within the tympanum expelled through the opening in the drum-head by the Politzer method of inflation and suction with Siegle's pneumatic speculum. After this has been accomplished the auditory canal should be cleansed thoroughly by means of a cotton-tipped probe wet with a 15-volume solution of hydrogen peroxid, the parts thoroughly dried, and covered with powdered boric acid by means of a powder-blower.

If exuberant granulations sufficiently large to obstruct free drainage from the tympanum occur, they should be removed by means of a snare (Fig. 172), by Hartmann's *rceps* (Fig. 158), or by touching them with *chromic acid* fused on the end of a probe. Considerable caution is required in the use of chromic acid. The granulations of small polypi should be first dried thoroughly by means of absorbent cotton, in order to prevent the acid dissolving and flowing over adjacent structures. No more of the acid should be applied than is necessary, to accomplish the desired result, and any excess remaining within the canal should be neutralized by syringing with a warm alkaline solution. Small polypi and exuberant granulations are most apt to occur and obstruct drainage when the pus has found its way through an opening in Shrapnell's membrane at a point on the upper and posterior part of the auditory canal. Much improvement often results from injecting a 5 per cent. solution of argyrol into the tympanum through the perforation every second or third day. The author has seen the discharge quickly cease in a number of cases as the result of one or more such intratympanic injections. As the solution frequently remains for several hours within the tympanum, its strength should not be over 5 per cent., as more concentrated solutions are capable of increasing the inflammation; nor should the injections be repeated oftener than once in two or three days.

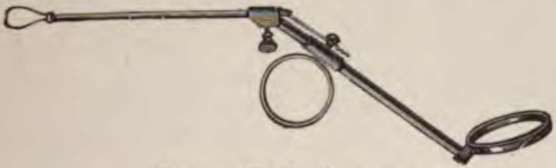

Fig. 172.—Blake's polypus snare.

Brilliant results have been obtained by vaccine therapy.

Otitis Media Suppurativa Chronica.—*Etiology.*—Chronic purulent inflammation of the middle ear is generally caused by neglect or improper treatment of acute purulent disease of the middle ear and the failure to secure adequate drainage. Adenoids, nasopharyngeal disease, and malnutrition prevent sometimes a prompt secession of an otorrhea. The affection may, however, develop primarily as the result of syphilis or tuberculosis. Numerous cases are the result of scarlatina.

Symptoms.—There is a mucopurulent or purulent discharge, sometimes tinged with blood. The acuteness of hearing varies according to the amount of destruction of the structures of the middle ear or to the presence of polypi or semi-inspissated secretions blocking the canal or interfering with functions of the ossicles. In some instances the hearing is nearly normal, while in others deafness is nearly absolute. Tinnitus may or may not be present.

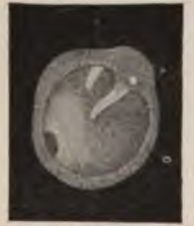

Fig. 173.—Residua of middle-ear suppuration. Nearly total loss of the drum-head. Handle of hammer resting on mucosa of promontory (Spalding).

The presence of a discharge in the auditory canal from the middle ear presupposes the presence of a perforation of the drum-head. The perforation, on the one hand, may be so minute as to escape observation by otoscopy, its presence being only revealed by a "perforation whistle" during inflation of the ear either by Politzer's or Valsalva's method. On the other hand, the destruction of the drum-head may be so extensive as to expose the cavity of the tympanum to view and reveal all of the structures of the inner wall (Fig. 173). In some cases the remains of the drum-head may be represented only by a narrow ring; in other cases the ossicles may have also disappeared, either from ulceration and sloughing of their ligaments or by necrosis of the bones themselves. Necrosis of some portions of the tympanic walls may also exist. To a considerable extent the position and size of the perforation will indicate the position and extent of the necrotic process (Fig. 174). The appearance of the tympanic mucous membrane varies somewhat. In one class of cases it is simply red and swollen, while in another class it appears granular and polypi may be present, perhaps covering the orifice of a sinus leading to exposed bone.

Usually there is a destruction of the ciliated epithelium and a thickening of the mucous membrane from infiltration of round cells with a dilatation and new formation of blood-vessels. Fungiform excrescences cover the thickened mucous membrane, which contains small cysts lined with cylindric epithelium containing epithelial cells, leukocytes, and detritus.

The *bacteria* in the discharges are generally numerous; as many as ten varieties are sometimes found in a single case. Even in tubercular infection the bacilli are found only at the beginning, for soon the pus cocci predominate and the tubercle bacilli are hard to identify.

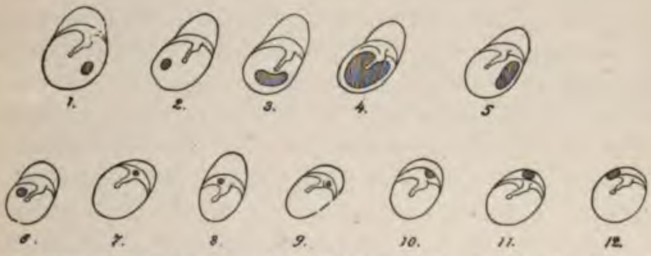

Fig. 174.—1–5, Simple suppurations of the drum-cavity and the eustachian tube; 6, 8, caries of the incus; 7, caries of the head of the malleus; 9, attic suppuration with possible caries of both malleus and incus; 10, 11, caries of the head of the malleus; 12, caries of the incus and suppuration of the antrum, and, possibly, associated cholesteatoma (Leutert).

Prognosis.—Untreated, some cases, after discharging for a year or two, finally cease discharging, the perforation in the membrane closes, and the hearing, while not entirely normal, becomes fairly good. This result is most likely to occur in cases with perforations similar to those shown in Fig. 174, 1–3. In other cases, where there is a large destruction of the membrane, the discharge ceases for a time, only to recur at intervals. In this class of cases there is only occasionally an apparent discharge, which for long intervals never appears externally. A scanty discharge, mixed with dust and other materials, dries at the fundus of the canal until it becomes a source of irritation, when, perhaps partly as the result of a cold, an abundant otorrhea is set up which sweeps away the old inspissated accumulations. Gradually this abundant otorrhea subsides until for another period no discharge appears externally. This is not an infrequent termination in cases where there is a large destruction of the membrane, as in Figs. 173 and 174, 4. In cases of this character occasional careful cleansing of the ear and in the case of a recurrent discharge one or two applications at intervals of a day of a 10 per cent. solution of argyrol will maintain the ear in a fairly satisfactory condition. Often the hearing is fairly good. The mucous membrane of the inner wall of the tympanum rarely epidermatizes and becomes entirely dry. Occasionally, where there is as nearly a complete destruction of the drum-head as in Fig. 173, the opening will become closed by a huge thin cicatrice, which, ballooning inward and outward with every change in intratympanic pressure, is rather a hindrance than an aid to hearing, but serves to exclude cold dust and other irritants.

Cases where there is a small opening in or just below Shrapnell's membrane leading to carious bone or an accumulation of filth (cholesteatomatous material) discharge indefinitely a scanty, watery fluid which sometimes dries upon the tympanum, forming an accurate cast of that structure when removed. Such so-called "attic cases" (Fig. 174, 6–12) are always a source of greater danger in the production of mastoid and intracranial complications than other forms of chronic otorrhea, although many attic cases reach a ripe old age with no more serious discomfort than partial deafness and a scanty discharge. Apparently there are no statistics bearing on the subject.

Treatment.—Conditions preventing the cessation of a chronic discharge from the middle ear are polypi; a pulpy or granular condition of the mucous membrane; insufficient drainage, because of a small perforation or one unsuitably situated; necrosis of one or more of the ossicles or of the tympanic walls; cholesteatoma.

In *chronic otorrhea*, the result of tuberculous infection, it is very difficult to bring about a cure of the suppuration even by the most radical operations. However, such cases usually die from the concomitant phthisis before the tuberculosis of the ear has progressed sufficiently to render a radical mastoid operation justifiable.

The *treatment* of uncomplicated cases consists in daily thorough cleansing of the interior of the drum, already described as necessary in the treatment of acute purulent inflammation of the middle ear. If the perforation through the membrana is not sufficiently large to permit of this being readily accomplished, it should be enlarged or a counter-opening made, and the interior of the drum syringed by means of Blake's middle-ear cannula (Fig. 28, 2, 3, or 4). When, with large perforation, pus is seen to flow downward from the attic into the tympanum, the nozzle of the curved cannula should be introduced into the attic through the perforation so as to thoroughly cleanse this cavity.

After the cavity has been thoroughly cleansed it should be dried carefully by means of absorbent cotton wrapped about a probe and the parts covered by powdered boric acid. The success of the treatment depends upon the thoroughness with which the cleansing is accomplished at each daily visit of the patient.

If the tympanic mucous membrane is granular the routine treatment outlined above will not be sufficient to secure a speedy cessation of the discharge until the granulations are destroyed. Alcohol has the power to cause a shrinking of the granulations because of its dehydrating qualities, and absolute alcohol may be applied by means of a cotton-tipped probe at each daily visit of the patient after the ear has been thoroughly cleansed. The application of absolute alcohol causes some pain, and it may augment the discharge for a few days. Alcohol (95 per cent.) may also be prescribed for the patient's use at home, 20 drops or more being instilled into the ear several times a day, care being exercised that the patient's head is held in such a position each time that the alcohol dropped into the ear will be sure to reach the cavity of the tympanum. For the first few days it may be necessary to dilute the alcohol somewhat because of pain. However, it should be remembered that the dehydrating properties of 50 per cent. alcohol are practically nothing. A good method of prescribing alcohol is to instruct the patient to mix in a 2-dram vial equal parts of alcohol and water for the first day's use. If this mixture causes only momentary pain, to use the next day 2 parts of alcohol and 1 part water, and so on from day to day until 95 per cent. alcohol can be used without great distress. When the discharges are fetid, compound tincture of benzoin should be substituted for alcohol until the fetor has disappeared.

Before dropping alcohol into his ear the patient or one of his friends should be instructed to remove all accumulations of pus from the ear in the following manner: The auditory canal is first straightened by drawing the auricle upward, backward, and outward. A cotton-tipped wooden toothpick is then inserted gently to the bottom of the canal, and then withdrawn and discarded. The procedure is repeated until cotton fails to absorb and bring away any discharge.

In case of a child, where the patient or nurse cleanses the ear, the child should be placed in front of a window before the canal is straightened, so that the light may be directed into the ear and a view of the fundus of the canal obtained.

Cleansing the ear by some method is absolutely necessary before dropping alcohol into it, as otherwise the alcohol will be diluted and the tissues protected by a layer of pus so thick in most instances that the alcohol will never reach the diseased parts.

If it is deemed wise to order the patient to cleanse his ears with a syringe, he should be carefully instructed as to the proper method (p. 386), and also how to dry the ear.

It is well at the first treatment of the patient with chronic otorrhea to begin by a thorough cleansing of the canal and tympanum by syringing with sublimate solution.

The writer has very serious doubts as to the value of home syringing, either by the patient or his friends. A girl about twelve years of age was brought to the Medico-Chirurgical Ear Dispensary some years ago almost totally deaf and with double facial paralysis as the result of scarlet fever. The odor from the child's ears was indescribably fetid. The mother stated that she had syringed the child's ears every day for the past six months. From the child's left ear there was quickly syringed a fetid mass of pus, the malleus, the incus, and part of the annulus tympanicus; from the right ear, fetid pus and the malleus. In six months of daily syringing the parent had evidently failed to remove any of the accumulation at the fundus of the auditory canal, but had simply syringed away some of its superficial portion. The case illustrates the value of home syringing of the ear as ordinarily performed.

For the patient's use the syringe made of a single piece of soft rubber (Fig. 27) is probably the safest and most effective instrument. All things considered, a warm saturated solution of boric acid is the most convenient detergent ear-wash for home use. The patient should be instructed to place 1 or 2 teaspoonfuls of the crystals in a wide-mouthed bottle holding about 4 ounces, fill the bottle with warm water, syringe the ear, and afterward cork the bottle. At each subsequent syringing a sufficient amount of boiling water from the tea-kettle is added to bring the saturated solution of boric acid up to a temperature suitable for syringing the ear. As the crystals of boric acid are dissolved, more should be added from time to time in order to maintain a saturated solution of boric acid conveniently ready for use.

However, a certain number of chronic otorrheas, especially those with large perforations, do better when syringed with bichlorid of mercury (1 : 5000 or 1 : 10,000) than with boric acid solution, and there is a very large proportion of such cases that experience little discomfort as long as they syringe their ears once a week or even at longer intervals with the bichlorid solution. In such cases astringents are much less effective than antiseptic solutions. However, most cases of acute and chronic suppuration, under ordinary circumstances of ready access to the aurist's office or the dispensary, do better without home syringing; and when alcohol or other drops are prescribed for home use, they are best dropped into the ear after a dry cleansing with absorbent cotton.

In a certain proportion of cases of chronic otorrhea the discharge continues because the tympanum is constantly reinfected from the eustachian tube. Yankauer has devised a set of three tubal curets by means of which the mucous membrane can be stripped from the tube at the isthmus, thus securing its complete closure. The tube is anesthetized with cocain and adrenalin and a curet of suitable size to fit somewhat snugly is passed through the tympanum into the tube as far as the isthmus and the mucous membrane stripped from the bone backward toward the atrium. The operation is followed by little reaction and in most instances results in at least diminution of the discharge.

Aural Polypi.—In some instances where a large perforation exposes swollen or granular mucous membrane upon the promontory, rapid cessation of a chronic discharge will be brought about by lightly touching the parts once or twice a week with a 25 per cent. solution of trichloracetic acid in conjunction with the treatment already advised for chronic suppuration. When the granulations are isolated they may be scraped away with a sharp curet or be removed with the forceps. Large granulations and polypi are best removed with a snare. It should be borne in mind, when removing a polypus with a snare, that, although the polypus is absolutely devoid of sensation, the wall of the auditory canal, as the result of long maceration in pus, is often exquisitely sensitive, and in guiding the wire loop of the snare over the polypus it is advisable to avoid, as far as possible, touching the auditory canal. If the polypus is large, an effort should be made to locate its pedicle by means of a probe. The wire loop of the snare should then be worked gradually inward over its surface until, if possible, the pedicle of the polypus is encircled. The wire loop should then be tightened to cut through the polypus. If the operator has not succeeded at the first attempt in removing the whole of the polypus, this maneuver may be repeated until the desired result has been accomplished. Bleeding may be checked at any stage of the operation by means of a tampon of absorbent cotton saturated with a 1 : 1000 solution of adrenalin, and by afterward cauterizing the stump of the polypus with nitrate of silver fused on the end of a probe.

Wilde, who was probably the first to design a snare for the removal of polypi, generally used his snare not to cut through the polypus, but to firmly grasp it and drag it from its attachment. The author has frequently used forceps for the same purpose; but it should be remembered that when latent diffuse labyrinthitis is present any operation in the middle ear may render the latent disease active, with resulting septic meningitis and death (p. 527).

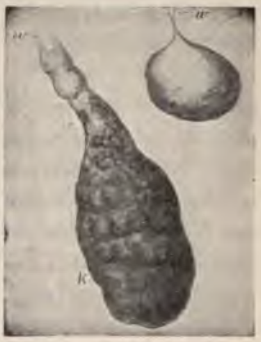

Fig. 175.—Polypi (Steudener).

Pathology.—Aural polypi (Fig. 175) may be divided into four classes. About 50 per cent. of all aural polypi are granulation tumors, having the same structure as ordinary granulations, but covered by either squamous or columnar epithelium; 90 per cent. of aural polypi, other than granulation tumors, are mucous papillomata. They are extremely vascular and sometimes bleed at the slightest touch. Their structure consists of capillary loops surrounded by a stroma of somewhat imperfectly developed connective tissue containing cuboidal epithelial cells. They are covered by a pavement epithelial layer of varying thickness. Fibroid polypi (fibromata), which are somewhat rare, are usually found as large, dense, pale polypi developed from the periosteal or deeper layer of the tympanic mucous membrane. Fibrous polypi are also covered by several layers of pavement epithelium. Myxomatous polypi are very rarely found in the human ear. Aural polypi are not malignant, the treatment outlined above being sufficient to prevent a recurrence of the growth. It should be borne in mind, however, that epitheliomata, sarcomata, and gummata sometimes occur in the middle ear and present the appearance of polypi, but such growths are rare in this situation.

Symptoms.—Long-continued discharge, often streaked with blood, is usually the only subjective symptom. Certain reflex symptoms, the result of peripheral irritation caused by the presence of an aural polypus, have been described as occurring in rare cases.

Most aural polypi have their origin at the posterior and upper part of the tympanum. They may, however, arise from any part of the tympanic cavity or even from the dermic layer of the drum-head. Sometimes they originate at the mouth of a sinus extending through the skin of the auditory canal to carious or necrosed bone.

Caries and Necrosis.—Caries or necrosis of the temporal bone may occur during the course of long-continued suppuration of the middle ear or as the result of syphilis, tuberculosis, trauma, osteomyelitis, and diabetes. The upper and posterior part of the auditory canal, the mastoid, and the tegmen of the tympanum and antrum are the portions most usually first involved. Caries most frequently attacks the cancellous bone; necrosis, the compact bone.

Symptoms.—Circumscribed caries may exist within the tympanum during chronic purulent disease of the middle ear and present no symptoms other than that exposed and roughened bone can be detected by means of a probe. Sudden paralysis of the facial nerve may occur as the result of necrosis of the inner wall of the tympanum involving the facial canal; however, a considerable portion of the facial canal may be opened and the nerve be bathed in pus for some time before symptoms of Bell's palsy occur. The labyrinth may be opened, generally through the horizontal semicircular canal, and a circumscribed or even a diffuse labyrinthitis with or without ultimate infection of the intracranial contents result. The tegmen tympani and tegmen mastoideum not infrequently are destroyed as the result of necrosis or caries. Under such circumstances there commonly occurs a local pachymeningitis, which prevents the spreading of the disease upon the dura mater. Pus may find its way into the nasopharynx or beneath the tissues about the auricle.

The necrosed bone in the more chronic cases is usually embedded in exuberant granulations, through which a probe detects, by the sensation of a rough surface, necrosed bone. If a cotton-tipped probe is used the rough surface catches in the fibers of cotton, producing a characteristic sensation.

Treatment.—The mere presence of localized spots of necrosis or caries upon one of the larger ossicles is hardly a sufficient reason for its removal. Perfect cleanliness and good drainage is ordinarily sufficient to bring about a cure of the condition. The rubbing of the parts with a cotton-tipped Allen probe that has been dipped in hydrogen peroxid, and proper daily intratympanic syringing will have a stimulating action upon the parts and aid the proliferation of epithelium over the diseased area. If these measures fail, the malleus and incus should be excised to permit freer access to the attic and better drainage, but in cases of suppuration of the antrum (Fig. 176) it is probable that a radical mastoid operation will be required to bring about a cessation of the discharge. If a sequestrum has formed, it should be removed with forceps. Politzer's forceps (Fig. 159) are usually strong enough for this purpose, but Sexton's or

Hartmann's (Fig. 158) foreign-body forceps can often be used to better advantage. If it be found impossible to remove the sequestrum through the auditory canal because of the granulations and polypi that obstruct the canal, they should be removed by means of a snare; after a few days, in some instances, the sequestrum will have been pushed outward by the granulations behind it into a position where it can readily be grasped by forceps and removed.

In cases of caries or where the necrotic process has not progressed to the formation of a sequestrum, the diseased bone should be scraped away by means of a sharp curet and the parts covered with powdered boric acid. When caries or necrosis affects the promontory only the most superficial cureting is justifiable; but the parts should be kept scrupuously clean and as *dry* as possible by means of frequent insufflations of powdered boric acid. Cases where necrosed bone can be felt in a portion of the tympanum inaccessible to the curet are best treated by instillations twice a day of enzymol, a preparation containing pepsin. By this means the middle ear is, as it were, converted into a stomach capable of digesting the dead bone. Pepsin, of course, has no effect on living tissue. The patient should then lie down with the diseased ear uppermost and fill the canal full of enzymol. The excess of fluid is allowed to escape when the patient assumes the erect posture. Several hours are required for the pepsin to produce its effect as a digestant, and the presence of granulations may prevent its coming into contact with dead bone. It is well, therefore, after enzymol has been used for a few days to employ instillations of alcohol for a day or two. However, when the ear is deaf and there is a fistula into the labyrinth it will be safer to do a radical mastoid operation to prevent the possible infection of the meninges.

The *prognosis*, of course, varies according to the part of the tympanum attacked by necrosis. In individuals otherwise *healthy the* prospects of a favorable result are encouraging, even when a large portion of the temporal bone is involved by the disease. In tuberculous individuals, however, the disease sometimes progresses toward a fatal termination notwithstanding all efforts to prevent it. The prognosis is doubtful where there are symptoms of intracranial involvement, pyemia, or metastatic abscess. Fatal hemorrhage may occur from the carotid when its bony canal is involved. The rupture of the vessel usually occurs at "Hassler's site of predilection," that is, at the knee of the carotid in the bony canal, where it abruptly changes its course from the vertical to the horizontal.

Aural cholesteatoma is an accumulation within the auditory canal and tympanum of a mass consisting of epithelial scales, cholesterin crystals, and inspissated pus, derived by desquamative inflammation from the lining membrane of the tympanum or mastoid cells.

The presence of cholesteatomatous masses usually causes impaired hearing and sometimes tinnitus, nausea, and dizziness. The bony and soft structures become absorbed as the result of the pressure caused by the accumulation, so that cholesteatomatous accumulations sometimes occupy large cavities.

Small collections of cholesteatomatous material are common at the upper and posterior portion of the auditory canal in cases in which perforation of Shrapnell's membrane has occurred. The mass often extends into the attic of the tympanum, sometimes into the mastoid antrum. Cholesteatoma are usually not easily detected at the first glance. Sometimes a small mass projecting into the meatus will be the only evidence of the presence of a cholesteatoma of considerable size. If, however, the small mass be removed, other masses will be found, until in some instances a cavity of considerable size will have been emptied of its contents.

Etiology.—When the membrana tympani is perforated as the result of disease or operative interference the opening in the drum-head generally promptly closes. If, however, a large portion of the drum-head is destroyed as the result of long-continued suppuration, the epidermis of the canal proliferates over the margins of the perforation and prevents its being filled by granulations; so that the perforation tends to become permanent. Furthermore, under certain conditions the epidermis of the canal proliferates over the walls of the cavities of the middle ear, and a greater or less extent of surface assumes a skin-like character and appearance. The entire tympanum, aditus, and antrum may become epidermized, but generally the epidermis extends but a short distance into the tympanum.

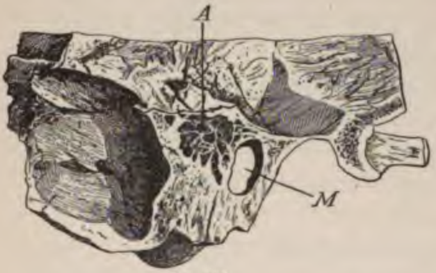

Fig. 176.

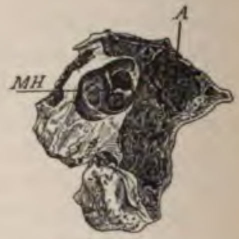

Fig. 177.

Fig. 176.—Vertical sagittal section through a left temporal bone; median surface of the lateral portion. The mastoid antrum, aditus, and attic of the tympanum are filled by a cholesteatoma. The mastoid process is sclerosed and its pneumatic cells are few and small: *A*, Antrum containing a portion of the cholesteatoma; *M*, auditory meatus. (From a photograph of a specimen in the author's collection.)

Fig. 177.—Lateral surface of the median portion of the same specimen. A part of the auditory meatus has been cut away and the specimen tilted toward the right in order to show the membrana tympani in the photograph, which is on a somewhat larger scale than Fig. 176: *A*, Aditus containing part of the cholesteatoma, which extends into and completely fills the attic; the tegmen of the aditus and antrum is extremely thin and discolored about a small perforation that extends from the antrum into the middle cranial fossa; *MH*, malleus handle attached to the promontory throughout its entire length in such a manner that the portion of the antrum anterior to the malleus is the only part of the middle ear communicating with the eustachian tube. The membrana tympani is cicatricial and collapsed. There are two large perforations posterior to the malleus handle and one anterior.

When the attic and antrum become epidermized, their lining membrane exfoliates as the result of chronic inflammation, and epidermic scales accumulate until the entire cavities become filled, as shown in Figs. 176 and 177.

Occasionally the presence of a small collection of cholesteatomatous material in the attic will cause a discharge through a fistula over the drum-head, and this scanty discharge, drying almost as it is secreted, forms closely adherent casts of the drum-head that might easily be mistaken for the drum-head itself. The removal of such casts from the drum-head is followed by considerable improvement in the hearing.

When the attic has become epidermized, scales of epidermis will be exfoliated from time to time, until a little ball of cholesteatomatous material will have collected in the attic and perhaps have extended into the aditus. The disintegration of such masses is a common cause of chronic suppuration and the growth of polypi. In every case of long-continued suppuration the presence of cholesteatoma may be suspected. It is rare to fail to remove by intratympanic syringing of the attic cholesteatomatous scales in cases of long-continued middle-ear suppuration in which the discharge originates within this cavity. The removal of such little masses, and also the granulation tissue or small polypi that their presence commonly causes, will in most instances be all that is necessary to bring about cessation for the time being of a chronic discharge that may have persisted for years. However, because cholesteatomatous prolongations force their way into the haversian canals, thus forming centers from which it may grow again, even the complete removal by curetment of the lining membrane of a cholesteatomatous cavity does not prevent a recurrence of the accumulation.

In most instances where it is necessary to resort to operative procedures for bringing about a cessation of a chronic otorrhea, the mere removal of the remains of the two larger ossicles will not be sufficient, and it is far preferable to resort to a radical mastoid operation which would certainly be necessary to bring about a cure of the chronic otorrhea resulting from a condition similar to that existing in Figs. 176 and 177, for it will be observed that the cholesteatomatous mass occupies the mastoid antrum as well as the attic, and it would be absolutely impossible to remove such a mass except through a comparatively large opening. However, it should be borne in mind that no operative procedure, even the removal of the lining membrane of the cavity by almost thorough curetment and the establishing of a large permanent postauricular opening, can be expected to bring about a permanent cure of chronic otorrhea due to the presence of cholesteatoma. This is perhaps due to the fact that cholesteatomatous prolongations force their way into the haversian canals, thus forming centers from which it grows again. Reinhard states that membranes still continued to exfoliate in the cases that he had operated upon by establishing a large permanent postauricular opening into the antrum, and required removal to prevent the recurrence of suppuration; "in some more frequently, sometimes but once in three years." The same rule applies to all cases of chronic suppuration where the middle ear has become epidermized. Whether an operation has been performed or not, cholesteatomatous masses will form, and their removal from time to time is necessary in order to prevent a recurrence of the suppuration.

Relapses after simple mastoid operations in cases of chronic otorrhea were notoriously frequent, and in all such cases the necessity for a secondary operation is the accumulation of cholesteatomatous masses within the middle ear. In some instances years may elapse before such masses cause marked aural symptoms, but finally suppuration occurs, and the mastoid antrum has to be reopened to permit the removal of material that fails to find a ready exit through the tympanum and the auditory canal. Therefore it is better in cases of mastoiditis occurring in the course of chronic suppuration to do a radical rather than a simple mastoid operation, except in young children.

In some instances nature does a Stacke operation as the result of necrosis of the lateral bony attic wall, or a large *permanent* postauricular opening may occur behind the auricle, leading directly into the antrum. In either case the middle ear becomes completely epidermized; but suppuration tends to recur if epidermal scales are not removed from time to time. The advantage of such large openings, secured either by nature or by the method of Reinhard, is that epidermal scales and other débris can readily be removed, and thus a cessation of the otorrhea brought about for a time. *However, it should never be forgotten that a radical mastoid operation in most cases of recurrent otorrhea when only the atrium is involved renders the patient's condition worse rather than better, because the vast majority of such cases go through life with fair hearing and only occasional suppuration, readily controlled by a competent aurist. That is, with very little if any more attention than many individuals require after a radical mastoid operation.*

SYSTEMIC DISEASES CAUSING OTIC INFLAMMATION

The systemic diseases most frequently causing otitis are scarlet fever, measles, diphtheria, grip, typhoid fever, pneumonia, syphilis, tuberculosis, and diabetes.

The appearance of otic inflammation in most of these diseases is a very serious complication, and although the subject has been already discussed in sections on the etiology and pathology of the various forms of otitis, it seems best to state briefly here the peculiarities of the otitis resulting from these systemic diseases and the modification of treatment necessary.

Scarlatina.—The middle ear is frequently involved during scarlet fever. In some cases the inflammation seems to be simply catarrhal in character, probably due to closure of the eustachian tube rather than the actual presence of the micro-organism causing the disease. Such cases run a mild course. There may not be perforation of the membrana. The deafness resulting in those cases where no perforation has occurred is often considerable.

When the ear complication occurs during the eruptive stage of scarlet fever it usually assumes a severe purulent type. The membrana and ossicles may come away as a slough in a surprisingly short space of time, and finally large sequestra of bone. The purulent inflammation may involve the labyrinth, with resulting total deafness, or the facial nerve, causing facial paralysis.

There is one practical point the practitioner should never forget, which is that the contagion sometimes lingers for several months in the discharge from the ear, and that a child with scarlatinal otorrhea may be the source of infection to other children.

The *treatment* of scarlatinal otitis differs in no respect from that of otitis from other causes, providing the condition of the patient will permit of its being carried out. The nose and throat should be cleansed once a day by the medical attendant with an atomizer containing Dobell's solution. The nose, if stenosed, should then be sprayed with adrenalin solution (1 : 5000) to overcome the stenosis and, finally, the mucous membrane covered with the spray of menthol-camphor-albolene and powdered calomel applied.

The ears should now be politzerized and, if discharging, gently syringed with a saturated boric acid solution and a piece of iodoform gauze placed loosely in the meatus. Every other day sublimate solution (1 : 2000) may be substituted for the boric acid solution should the gravity of the case seem to require it.

In some cases the patient, especially if a child, will be too weak or indocile to permit of so lengthy a treatment, and the practitioner may have to content himself with simply syringing with boric acid or sublimate solution.

Sequestra of necrosed bone, polypi, mastoid complications, and intracranial involvement, if the condition of the patient permit, should be treated in the manner described in other sections.

Measles.—The ear is usually affected in measles, but with less virulence than in scarlatina. The condition is usually that of the catarrhal type, acute or subacute. Rarely does perforation occur.

Treatment is the same as in similar types of otitis from other causes.

Diphtheria.—Otitis media purulenta is not very infrequent in diphtheria. When the drum is perforated pseudomembranes may extend from the middle ear on to the excoriated skin of the canal. In those with otorrhea, diphtheric pseudomembranous infection may occur in the tympanum if they are brought into contact with diphtheric patients.

Treatment is similar to otitis from other causes. When the membrana has ruptured and a pseudomembrane is visible the condition should be treated as described in the section on Diphtheria of the Meatus.

Grip.—Aural complications in epidemics of influenza are very frequent. Minute hemorrhages into the drum-head or beneath the epidermis of the canal are not infrequently encountered and are somewhat characteristic of the disease.

The aural complications vary from a subacute catarrh, from which recovery takes place within a short time, to severe otitis media purulenta with intracranial complications. The possible gravity of an aural complication in a case of influenza should not be underestimated, and such a case should receive the most careful attention from its onset.

The *treatment* is similar to otitis from other causes.

Typhoid Fever.—The hebetude and apparent deafness of typhoid is due to the effect of the toxins of the disease on the internal ear. Occasionally internal ear impairment of hearing is encountered years after recovery from the fever.

Purulent inflammation of the middle ear is the result of invasion of the Bacterium coli into the middle ear. Day and Jackson, of Pittsburgh, describe three types of purulent otitis in typhoid—the hemorrhagic, the slow, and the fulminating. The disease is usually rapid in its onset and characterized by intense pain. Day and Jackson state that in 10 cases no otitis was manifest one or two days previous to spontaneous rupture of the membrana.

In the Medico-Chirurgical Hospital during the Spanish War, of 268 soldiers sick from typhoid fever 3 had severe otitis media purulenta as a complication of the disease.

The ear complications of typhoid occur usually in the third or fourth week. The symptoms vary from those of subacute catarrh to the severe form of middle-ear suppuration. Hemorrhagic blebs similar to those encountered in aural influenza have been observed by Day and Jackson previous to rupture of the drum-head.

The *treatment* is that of otitis elsewhere when the condition of the patient will permit. The danger of heart failure from sitting up in bed, and nasal hemorrhage as the result of using the spray and Politzer's bag, should be borne in mind. In some cases, for a few days at least, it is best to be content with simply syringing the meatus with boric acid solution twice a day and inserting a little iodoform gauze *loosely* into the concha. It is better to avoid inserting gauze into the canal, especially if the dressing be entrusted to a nurse, for fear that the gauze will become impacted from some cause, possibly the finger of the patient. The gauze should be changed as often as it becomes saturated. Pressure-pain with bulging of the drum-head will indicate paracentesis.

Tuberculosis of the middle ear is probably always secondary in phthisis. Tuberculous deposits occur in the middle ear, which after a time break down, causing more or less rapid destruction of tissue. The most marked symptom is the *painless character* of the otitis media-purulenta that results in perforation of the membrana. After a considerable destruction of the drum-head has occurred the parts not infrequently become sensitive, probably as the result of mixed infection. Ordinarily the disease pursues a chronic course, and otorrhea may even cease for a time and reappear.

Sometimes the destruction of tissue is rapid and the disease extends to the mastoid, necessitating operation. Caries of the bone may involve the facial nerve and cause facial paralysis, or the internal ear may be invaded. Pus, in the more severe forms of the disease, is abundant and fetid, but tubercle bacilli are not usually numerous or easy to find in the discharges.

It should be borne in mind in this connection that otitis media purulenta may occur in a tuberculous individual without the disease being due to tuberculosis.

Treatment.—The general treatment is of primary importance and consists of a diet largely of milk and raw eggs, outdoor life, and tonics. Local treatment is usually not very successful in bringing about a cessation of the discharge. The parts, however, in the middle-ear suppuration should be kept clean, either by the dry method or by syringing with boric acid and sublimate solution. It should be borne in mind that the discharges are contagious and care should be exercised to destroy all dressings used about the ear.

Pneumonia.—As in typhoid, otitis media purulenta generally occurs late in the disease, if at all. The pneumococcus is not infrequently found in the pus of an otorrhea occurring independent of pneumonia.

The *treatment* is the same as in otitis occurring from other causes.

Syphilis.—The middle ear is frequently inflamed during the period of secondary skin rashes and sore throat. In a case observed by the author facial paralysis occurred. The middle ear may become the seat of a gumma in the tertiary period of the disease. The symptoms at first are those of pressure within the middle ear, deafness, tinnitus, and sometimes vertigo. Sooner or later suppuration with perforation of the membrane occurs, and the disease assumes the appearance of chronic otitis media purulenta. The destruction of tissue is often considerable.

Treatment.—The local treatment is that of otitis; the constitutional treatment being of greater importance. In cases where the diagnosis of gumma is made early, inunctions of mercury with iodid of potassium internally may result in absorption of the gumma before it breaks down.

Bright's Disease.—In advanced Bright's disease all operations under a general anesthetic about the nose, throat, and ear are dangerous because of the possibility of fatal coma.

Diabetes.—Recurrent furunculosis of the canal may result from glycosuria. Mastoid wounds and large wounds about the upper respiratory tract do not heal as rapidly in well-marked glycosuria as in a normal individual, and otitis media purulenta runs a more severe course with greater destruction of tissue.

Debility and **excessive fatigue** or excitement reduce the acuteness of hearing very noticeably when it is already defective from middle-ear catarrh or as the result of suppuration. The same is true of shock resulting from a serious accident, even when the individual though present was not seriously injured. Under such circumstances the hearing may be seriously impaired for many months before it somewhat gradually becomes as acute as before the accident.

OPERATIONS UPON THE MIDDLE EAR

Operations are performed upon the middle ear for the improvement of hearing, the relief of tinnitus aurium or vertigo, and to bring about the cure of a persistent discharge from the middle ear.

The operations that have been performed from time to time are quite numerous, the following being a partial list: *Paracentesis*, single or multiple; *excision*, or destruction by caustics of a portion of the membrana tympani for the purpose of establishing a permanent opening; *plicotomy* or division of the posterior fold; *section* of the anterior ligaments of the malleus; *tenotomy* of the tensor tympani or stapedius muscle, or both; *division* of adhesions between the membrana and promontory or between the ossicles, etc.; *excision* of a portion of the membrana; *disarticulation* of the incudostapedial articulation or division of the descending process of the incus and mobilization of the stapes; *plastic operations* for uniting either the incus or stapes with the membrana tympani; and *removal* of one or more of the ossicles.

Severing the Incudostapedial Articulation and Mobilizing or Extracting the Stapes.—A general anesthetic may be administered, but it is preferable to operate under cocain anesthesia in order to secure the co-operation of the patient and to test his hearing from time to time during the different stages of the operation. The field of operation is prepared, upon the preceding day, by carefully cleansing the auditory canal with a solution of hydrogen peroxid and syringing with a 1 : 2000 solution of corrosive sublimate, after which the auditory canal is stopped with a plug of iodoform gauze. All instruments, the absorbent cotton, and the solutions of cocain are sterilized in the usual manner by heat. Anesthesia is secured by the method of Balin, which consists in subcutaneous injection into the roof of the canal of a mixture

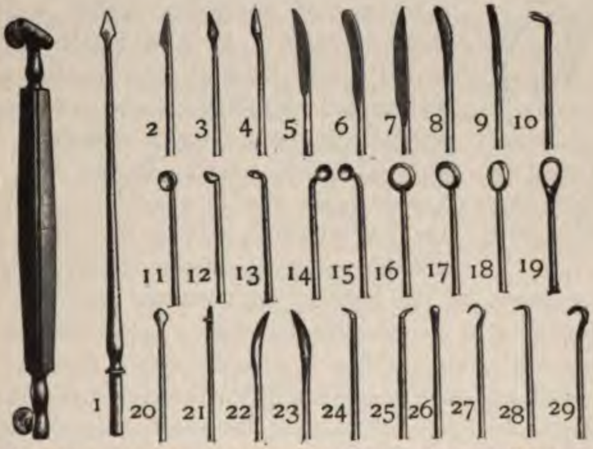

Fig. 178.—Pocket case instruments for minor surgery of the auditory canal and tympanum.

of equal quantities of a 1 per cent. solution of cocain and a 1 : 1000 solution of adrenalin (Formula 11).

Technic.—Commencing rather below the middle of the posterior periphery of the drum-head, an incision is made and prolonged upward with the probe-pointed knife (Fig. 178, 6) through the clear portion of the drum-head close to the annulus, beneath the posterior fold, and for a short distance downward along the malleus handle (Fig. 179). Little more than a fraction of a drop of blood ordinarily follows the incision, but the flap should be turned forward, and a pledget of absorbent cotton wrapped about the end of an Allen probe and saturated with a solution of adrenalin should be held in contact with the cut surfaces and the tympanic mucous membrane until all bleeding has ceased. Before proceeding further with the operation it is well to test the patient's hearing with both voice and the watch, in order to ascertain if any improvement in the hearing has resulted from the artificial opening in the drum-head. This is rarely the case.

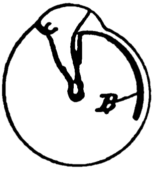

Fig. 179.—Diagram of the left membrana tympani: *B*, Incision through the drum-head.

Generally when the flap is turned forward it remains in that position, and a good view of the interior of the drum is obtained. If this is not the case, the incision should be continued downward along the posterior border of the malleus handle until the flap does not tend to close the wound and obstruct the view. The region of the round window should be carefully inspected and any abnormality noted and remedied, if possible, at a subsequent stage of the operation. If the incudostapedial articulation is not visible, it is brought into view by inclining the patient's head strongly toward his opposite shoulder, so that it is possible to see upward beneath the posterior fold. The incus-hook (Fig. 178, 10) should now be passed around the descending process of the incus close to the stapes and an effort made to mobilize the ossicles by gentle traction in anterior, posterior, and lateral directions, and any improvement in the patient's hearing noted. If none occurs, the tendon of the stapedius muscle should next be divided with the point of the sharp-pointed knife (Fig. 178, 24 or 25) by a downward stroke close behind the incudostapedial audible articulation. Sometimes the tendon gives way with an audible snap and immediate improvement in the patient's hearing follows. If, however, the hearing is not improved, the incudostapedial articulation should be severed by means of an angular knife, which is made to cut downward through the joint either from in front of or behind the incus-shank, which it hugs closely while the downward stroke or strokes are being made. If the knife cannot readily be passed beyond the incus-shank, either in front of or behind it, the joint may be severed from below with the point of the knife. After the incudostapedial articulation has been severed the incus-shank is pushed forward and upward in order to diminish the possibility of its tip reuniting with the stapes. After severing the incudostapedial joint, if the patient's hearing still remains unimproved, the point of the sharp-pointed knife may be cautiously carried about the head of the stapes, within the pelvis of the oval window, and an attempt made to mobilize the stapes by means of an Allen probe about the end of which a few fibers of cotton have been wrapped. The head of the stapes should be gently pressed upward, then backward, then forward, care being exercised that sufficient force is not employed to endanger fracturing the crura of the stapes, which, as the result of atrophic changes, are sometimes very fragile. If, in spite of these manipulations, the bonelet remains firmly fixed and the patient's hearing unimproved, an attempt may be made to remove the ossicle by traction with a hook. If bony ankylosis exists between the foot-plate of the stapes, Politzer has shown by experiments on the cadaver that the effort will not succeed, but that the crura will be fractured in the effort to remove the stapes. A portion of the foot-plate may, however, be removed with the fragment of the crura of the stapes and the patient's hearing improved, at least for a time.

After the completion of the operation the edges of the wound in the drum-head are brought together and supported by a small amount of boric acid or iodoform insufflated by the powder-blower. Ordinarily the edges of the wound quickly unite, but suppuration has been reported as following the operation in a few instances.

Prognosis.—In all intratympanic operations the prognosis is uncertain. The prognosis as regards diminishing tinnitus is much better than that of improving the hearing to a useful degree. The author performed this operation a considerable number of times some years ago. In many cases there was permanent improvement as regards tinnitus and temporary improvement of hearing. (See former editions of this manual for details.)

Operations for the relief of deafness and tinnitus resulting from chronic suppuration of the middle ear are division or divulsion of false membranes and adhesions binding the ossicles together or to the tympanic walls in such a manner as to interfere with the vibration of the stapes; mobilization or removal of the stapes; removal of the remains of the drum-head and the two larger ossicles.

In most instances the first ossicle to become carious or necrosed as the result of chronic intratympanic suppuration is the incus, because of its imperfect blood-supply as compared with that of the other intratympanic structures. The entire bonelet may disappear as the result of a few weeks of intratympanic suppuration. Ordinarily the descending process is the first portion of the incus to disappear, thus freeing the stapes. The comparatively good hearing of the patients with large dry perforations of the membrana is due in many instances to the fact that the stapes is thus freed at an early stage of the suppurative process, and does not become involved by subsequent contractions and adhesions. In some instances, however, this fortunate result does not occur, and the detached stapes may be completely buried in a mass of cicatricial tissue which holds it immovable in the pelvis of the oval window. When not detached from the incus the movements of the stapes may be interfered with by bands of tissue binding the two larger ossicles together or to the tympanic wall. The most common of such bands is one extending from the long process of the incus to the tympanic wall and the malleus handle (Fig. 180).

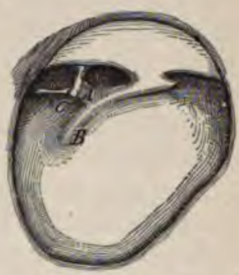

Fig. 180.—*A*, Band of connective tissue extending from the long process of the incus, *C*, to the malleus handle, *B*, which was adherent to the promontory. Hearing for the watch increased from 2 inches to 2 feet as result of divulsing this band by gentle traction with an Allen probe, the point of which was bent nearly at a right angle and inserted underneath the band. The improvement lasted for nearly three years, when the operation was repeated, with equally satisfactory results.

Division or divulsion of such bands is, in some instances, followed by the most astonishing improvement in the hearing power and the complete relief of tinnitus. In suitable cases more permanent results are secured by divulsion or stretching of the bands than by cutting them. In some cases the vibrations of the ossicular chain are interfered with by an adhesion of the remains of the drum-head to the promontory in such a manner as to bind down the malleus handle. Under such circumstances division of the adhesion is followed by improved hearing and decreased tinnitus. In most instances divulsion of intratympanic bands and adhesions will have to be repeated from time to time in order to secure permanent results; but as the operations are by no means formidable, when required they may be done during an ordinary office visit. In the divulsion of bands and adhesions care should be exercised that sufficient force is not employed to endanger dislocation of one of the ossicles, more especially the stapes. After division of synechiæ and surgical mobilizing of the stapes the hearing power can sometimes be increased by the use of an artificial drum-membrane; for this purpose a membrane made of paper, as first employed by Blake, answers an admirable purpose, and is sometimes followed by so much permanent improvement of the hearing that its use can finally be dispensed with. The permanent improvement is doubtless due to "automobilization" of the stapes during hearing as the result of wearing the disk.

The removal of the two larger ossicles, or what remains of them, is admissable as a means of improving the hearing or diminishing tinnitus; but cases are hardly conceivable in which all the improvement possible, as regards both tinnitus and hearing, cannot be secured by the division of adhesions, disarticulation of the incudostapedial joint, or mobilization of the stapes.

Operation for the Removal of the Remains of the Drumhead, Malleus, and Incus in Suppurative Cases.—The operation is better done under cocain anesthesia by the transfusion method of Ballin (Formula 11) or a general anesthetic may be employed. However, when a large amount of the intratympanic mucous membrane is exposed as the result of disease, except in nervous patients, simply the application of a 10 per cent. solution of cocain yields fairly satisfactory anesthesia.

If the incudostapedial articulation is intact and visible, it is well to begin the operation by severing the joint, to avoid possible injury to the stapes while removing the incus. If the membrana flaccida is intact, a sharp-pointed knife is thrust through it behind the short process, as close as possible to the margin of the annulus, and the incision continued backward and downward for a sufficient distance to completely sever the posterior attachments of the malleus. Without removing the knife from the wound its edge is turned in the opposite direction, its point is slightly withdrawn so as to ride over the malleus above the short process, and the anterior attachments of the malleus are rapidly severed. The neck of the malleus is seized with foreign-body forceps and an effort made to dislodge the head of the malleus from the scute or shelf of bone on which it lies on the lateral portion of the attic, by gentle pressure inward and downward with the forceps. Should gentle manipulation not succeed, it is probable that the malleus is held in position by adhesions to the tympanic walls. Any adhesions that can be reached should be severed by means of angular knives (Fig. 178, 24 and 25). By means of one of these knives or the incus-hook (Fig. 178, 29) traction directly outward should be made upon the tip of the malleus handle until the head of the bonelet is dislodged inward. If now the bonelet be seized in the neighborhood of the short process with the foreign-body forceps it will readily be removed by traction—at first inward and downward and then outward.

The malleus when withdrawn from the ear should be inspected to determine whether or not the incus is adherent to it. In not a few instance the bonelets will be found firmly bound together by bony ankylosis or strong fibrous bands, so that both bonelets will be removed together. If this does not occur, and the presence of the incus has been determined previous to the operation by the use of an Allen probe, the tip of which has been bent upward and guarded by a few fibers of cotton wrapped about it, a diligent search should be made for the incus by means of incus-hooks (Fig. 178, 10, 14, 15). The incus will probably be found behind the annulus, dislocated downward and outward as the result of the withdrawal of the malleus. The tip of its long process will probably be found close behind the annulus posteriorly and somewhat below the middle of the tympanum. If the incus-hook be introduced into the lower part of the tympanum, with its concave surface upward and the tip of the hook behind the annulus, by lifting the hook slightly upward and at the same time rotating it the long process of the incus will probably be pushed anteriorly into view from behind the annulus. In executing this maneuver it is necessary that the tip of the hook be held somewhat closely in contact with the median surface of the annulus. The rotation of the hook may have to be repeated several times before the incus-shank is brought into view. The ossicle will probably be found lying somewhat lower down in the tympanum than would naturally be expected, but if careful manipulation of the hook fails to locate it in this region, the ossicle should be searched for higher up, and, if necessary, the other hook may be inserted with its concavity downward and its tip behind the scute, and rotated in such a manner as to dislocate the ossicle downward. This maneuver should be executed with great care and gentleness, as there is danger of pushing the ossicle backward into the antrum. After the incus is brought into view it should be seized with the forceps, manipulated in such a manner as to free it from the annulus, and withdrawn.

It should be borne in mind that the first portion of the ossicle destroyed by caries is the long process, and that it sometimes requires but a short period of suppuration to cause the entire destruction of this ossicle. Too prolonged search for the incus after the removal of the malleus is not advisable unless it is certain from previous examinations that the incus is certainly present.

After the withdrawal of the incus the edge of the annulus and the tympanic vault should be carefully searched by means of a cotton-tipped probe for exposed bone or areas of granulations. If such spots be found, they should be carefully cureted by means of a bent curet (Fig. 178). The success of the operation in bringing about a cessation of persistent or recurrent suppuration will often depend upon the thoroughness and care with which this is done. Any remaining portions of the membrana should also be removed with the probe-pointed knife or with a curet.

In operating upon the anterior or inferior portion of the tympanum the position of the carotid artery and the bulb of the jugular vein should be borne in mind (Figs. 181, 199, 206). Ordinarily the jugular vein is covered by bone of sufficient thickness to prevent injury to the vessel, but sometimes this bone is lacking and the vein lies just below the tympanic mucous membrane. Several cases of injury to the jugular vein during intratympanic operations have occurred, but without fatal results. Although no cases of injury to the carotid artery during operations upon the middle ear are known, yet the artery lies dangerously near anteriorly, and it is well to use a probe-pointed knife when operating in this locality. Hemorrhage from this portion of the artery as the result of necrosis has almost invariably terminated fatally, even after ligation of the internal carotid artery.

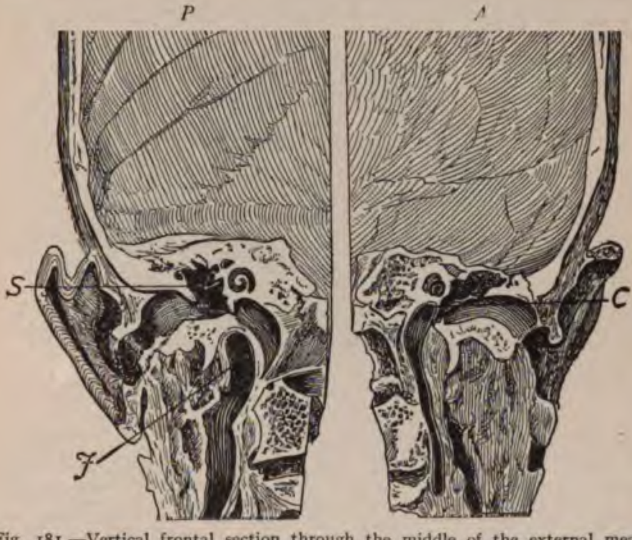

Fig. 181.—Vertical frontal section through the middle of the external meatus: *A*, Anterior, *P*, posterior portion of the specimen; *S*, scute or external bony wall of attic; *C*, carotid artery; *J*, internal jugular vein. The carotid is separated from the anterior median wall of the tympanum by an extremely thin septum of bone, which in numerous instances is entirely lacking, so that the vessel might be wounded by the knife of a heedless operator during an intratympanic operation. The bulb of the jugular vein is separated from the cavity of the tympanum by the mucous membrane and a thin septum of bone that is sometimes lacking. The bulb of the jugular vein has been wounded during the operation of paracentesis. In the specimen the drum-head, malleus, and incus have disappeared as the result, probably, of chronic suppuration. (Author's specimen.)

After the removal of the malleus and incus, if it be deemed necessary in order to gain better access to the attic for after-treatment, the lateral wall of the attic may be removed by means of a small chisel or curet (Fig. 197).

The after-treatment of the operation consists in daily cleansing of the parts with absorbent cotton and the insufflation of powdered boric acid.

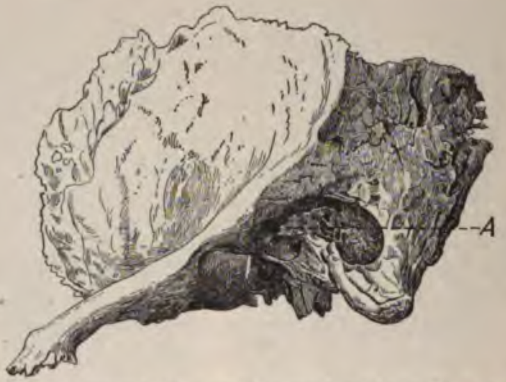

Fig. 182.—Adult temporal bone, with the upper and part of the posterior wall of the meatus chiseled away so as to form one large cavity of the meatus, tympanum, and antrum: *A*, Hard ridge of bone surrounding the fallopian canal. Within the tympanum the oval and round windows are plainly shown. It should be borne in mind that the facial nerve arches backward above the oval window and then descends vertically (Figs. 126, 127, 202, and 203). The inner end of the ridge of bone between the auditory canal and mastoid near *A* is, therefore, not far distant from this nerve, and considerable caution should be used in smoothing down this portion of the ridge, the outer portion of which can be removed quickly with rongeur forceps without pain or difficulty. In a complete Küster operation healing will be facilitated and a better final result obtained by removing not only the ridge between the canal and the operative cavity in the mastoid but also the overhanging edge of bone about this cavity, both above and behind, to render the operative cavity as flat, smooth, and shallow as possible. The root of the zygomatic process and the tip of the mastoid contain cells, and in most instances it is desirable to open these cells thoroughly. The ridge between the canal and the operative cavity and overhanging edges have been allowed to remain in order to better show the topography. (Author's specimen.)

Mastoiditis.—*The External and Middle Ear of a Newborn Child.*—At birth the external meatus is essentially a closed canal. The drum-head lies nearly in the same plane with the upper wall of the meatus (Fig. 183), and forms such an extremely acute angle with the lower wall that the upper and lower walls are practically in contact except for the *vernix* *caseosa*, which, covering the entire body of the child at birth, also extends into the auditory canal, completely blocking it up so that no air can enter. The drum-head is covered by extremely thick epidermis, while the cavity of the tympanum is usually completely filled with its own mucous membrane, which, enormously hypertrophied at all parts of the tympanum, is thickest upon the inner wall, where it is markedly hyperemic and jelly-like in appearance, in marked contrast to that of adult life, which upon the promontory is thin and nearly bloodless in appearance.

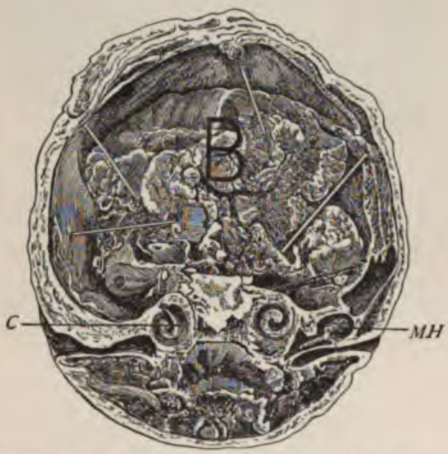

Fig. 183.—Vertical frontal section through the external auditory canals of a fetus stillborn at the end of the seventh month, anterior portion of the head. The external auditory canal slopes somewhat downward and the membrana tympani are nearly horizontal. The lower wall of each canal is in contact with the upper except for the presence of a small quantity of the same cheesy material (*vernix caseosa*) that covered the rest of the skin of the fetus. The tympanum is completely filled by the ossicles and its own mucous membrane, which is much thicker than that of the adult. The malleus is in position in the right ear, but has been removed by the saw from the left: *B*, Brain; *MH*, head of the malleus; *C*, cochlea of the left ear. (Author's specimen.)

Hence the offspring of the human race, like that of many of the lower animals, is born into the world almost completely deaf. Almost from birth the eyes of the infant follow the movements of individuals about the room, but it is not until the eighth or tenth day after birth that an infant shows any evidence of hearing the sound of a tuning-fork held close to its ear. At birth or soon afterward the tympanum becomes a cavity containing air. The thick epidermis of the outer layer of the drum-head is exfoliated and the mucous cushions within the tympanum disappear.

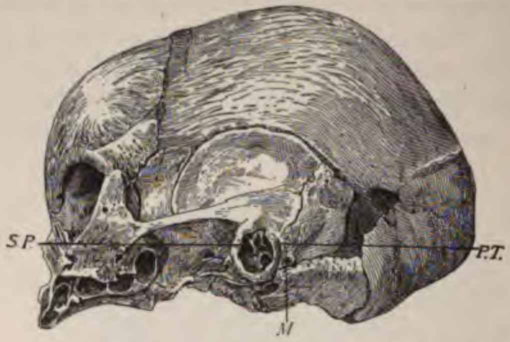

Fig. 184.—Left half of the skull of a stillborn infant, showing the inferior surface of the petrous bone, the annulus tympanicus, the ossicles, the tympanum, and the mastoid process. The ossicles, the tympanum, and the mastoid antrum are nearly as large as those of an adult: *M*, Mastoid process. The end of the line is at the stylomastoid foramen. Hence at birth the facial nerve emerges not, as in the adult, on the inferior, but on the lateral, surface of the temporal bone. Therefore it readily may be wounded during a mastoid operation by a careless operator or injured by too tightly packing or bandaging the mastoid wound; *S.P.*, short process of the malleus; *P.T.*, posterior tubercle of the annulus tympanicus. (Author's specimen.)

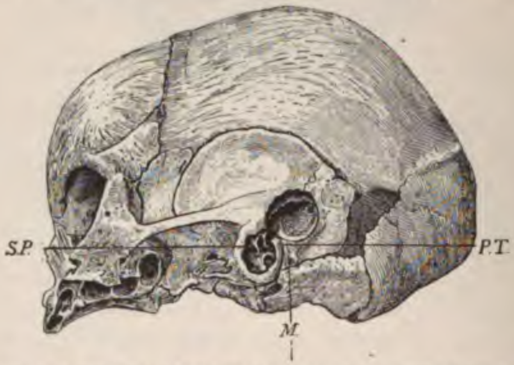

Fig. 185.—Same specimen as Fig. 184, but with the mastoid antrum exposed, showing its normal position at birth immediately above the posterior tubercle of the annulus. In most instances it has assumed the position of adult life when the child is two years old.

The temporal bone ossifies from eight centers. These have coalesced at the end of the fifth month, but even at birth the bone readily separates into three parts (Fig. 186). The osseous canal of the adult is represented in infants by the *annulus tympanicus* or *processus auditorius* (Figs. 184, 186), which forms by gradual development the vaginal process of the auditory meatus of the adult. The rest of the canal is composed largely of embryonic tissues covered by skin, and measures from the tragus to the umbo usually about 30 mm., while that of the adult measures from 31 to 35 mm. between the same structures. Because of the nearly horizontal position of the drum-head, Shrapnell's membrane (Fig. 124) lies so near the orifice of the canal that when greatly swollen it almost protrudes, resembling somewhat a polypus in appearance; indeed, it has been mistaken for a polypus and removed, together with the malleus and incus.

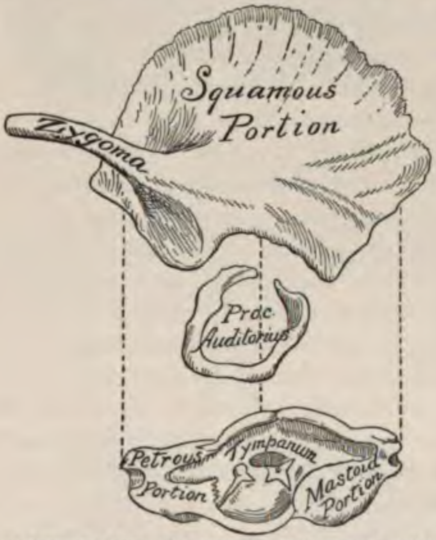

Fig. 186.—The temporal bone of a newborn child separated into its three component parts: the squamous and petrous portions and the annulus tympanicus or processus auditorius (Gray).

To *examine the drum-head of young children* it is necessary to draw the lobule downward in order to detach the lower from the upper wall of the meatus. The ossicles, tympanum, and mastoid antrum are nearly as large as those of an adult, but are superficially situated, and in opening a mastoid abscess in an infant, therefore, it is not unusual for the probe to pass through the antrum into the attic for a distance of nearly 1 inch. The mastoid antrum of young infants is situated immediately above the posterior tubercle of the annulus (Fig. 184), and this elevation should be searched for as a landmark when operating upon the temporal bone of infants. It should also be borne in mind that the mastoid-squamous suture (Fig. 184) is not ossified at birth, and frequently presents large dehiscences during childhood, so that when making the primary incision for a mastoid operation upon a young child the point of the knife should not be pressed with force against the bone or it may enter one of these dehiscences and penetrate the cranial cavity. The incision should be made with due deliberation until the bone is exposed in the whole length of the incision, and the periosteum pushed forward with great care and gentleness. It should be borne in mind also that at birth the *facial nerve* emerges not on the inferior surface, but on the external (lateral) surface of the temporal bone, at a point close to the annulus and somewhat above its inferior border (Fig. 184). Unnecessary cureting within the mastoid antrum and attic should also be avoided, as the petrosquamous suture, where the horizontal plate of the squamous portion of the temporal bone unites with the petrous portion to form the tegmen or roof of the tympanum and antrum, remains open for some time after birth, and a process from the dura not infrequently extends downward to unite with the mucous membrane of the middle ear.

The Adult Mastoid Process.—At birth the mastoid process consists of a small flattened tuberosity containing but one cell, the mastoid antrum. At the age of eight years the child's mastoid generally contains numerous other pneumatic spaces radiating from the antrum. At puberty the

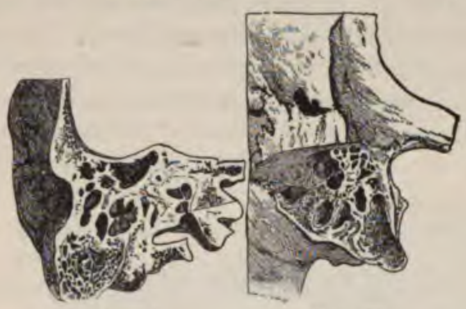

Fig. 187. Fig. 188.

Figs. 187, 188.—Large-celled pneumatic processes: the tip of the one to the left diploëtic. (Author's specimens.)

mastoid has become a distinct prominence, conic in shape, with its apex downward. It may or may not contain pneumatic cells in addition to the antrum.

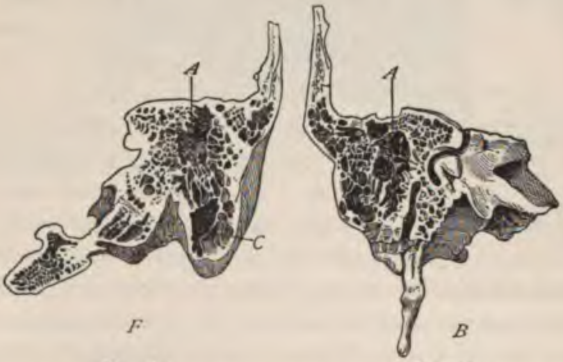

Fig. 189. Fig. 190.

Figs. 189, 190.—Frontal section through the spina of a mastoid process consisting almost entirely of small pneumatic cells: Fig. 189, Anterior, Fig. 190, posterior portion of the specimen; *A*, antrum; *C*, large cell at the tip of the process; the semicircular canals and the aquæductus fallopii have been laid open after the section was made. (Author's specimens.)

Types of Mastoid Structure.—There are four distinct types of mastoid structure:

1. The pneumatic, in which the whole mastoid process is composed of pneumatic spaces communicating with each other and with the antrum, and lined with a continuation of the mucous membrane of the middle ear. The pneumatic spaces may be large (Figs. 187 and 188) or small (Figs. 189 and 190). If the pneumatic spaces are small, one comparatively large cell is generally found at the mastoid tip.

2. The diploëtic, the entire bone containing no air spaces, but composed of diploëtic tissue.

3. The pneumodiploëtic, in which pneumatic spaces and diploëtic tissue are both found (Figs. 187 and 188).

4. The sclerosed, in which the entire bone is composed of compact bone often as hard as a tooth (Fig. 191).

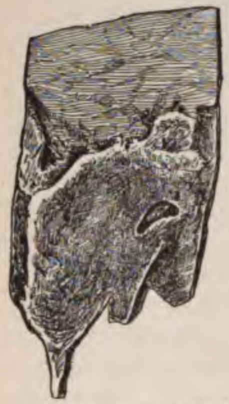

Fig. 191.—A vertical sagittal section through a sclerosed mastoid process, the cellular structure of which, with the exception of an exceedingly small antrum, has been entirely replaced by dense eburnated bone. (Author's specimen.)

Pathologic Importance of Types.—Pathologically and surgically the structure of the mastoid process is of the utmost importance. In the pneumatic type of mastoid with large cells, pus from the antrum readily finds its way to the lateral surface, but in the diploëtic, and more especially in the sclerosed type, there is greater danger of pus burrowing its way into the cranial cavity. The difficulties of the mastoid operation are also greatly increased by the compactness and hardness of the bone. Where a large cell is present at the mastoid tip with a thin median wall, pus is more likely to find its way into the digastric fossæ than to penetrate the thicker external cortex. Long narrow or dolichocephalic skulls have pneumatic processes oftener than brachycephalic or round skulls. In round skulls the external canal is proportionately longer, that is, the ear lies deeper. Often there are no cells, so that the sinus and dura are very close to the external meatus and the middle ear (Fig. 199).

Etiology.—Primary inflammation of the mastoid rarely occurs except as the result of syphilis, tuberculosis, or traumatism, especially in individuals with chronic suppuration of the tympanum and attic. The symptoms are those of acute periostitis, pain, heat, and swelling behind the ear. Within a few days the periostitis subsides or the deeper structures become involved. In such cases should caries occur, the abscess cavity does not usually communicate with the mastoid antrum, but is generally superficially situated beneath the cortex of the bone. However, the disease in almost every instance is the result of an extension by continuity of structure, of inflammation from the tympanum. Mastoiditis, then, is generally the sequence of acute inflammation of the tympanum or of chronic suppuration of the middle ear. In rare instances suppurative inflammation of the deeper portion of the auditory canal may extend under the periosteum until pus appears upon the external surface of the mastoid beneath the periosteum (Fig. 192); or infection may be transmitted by means of the

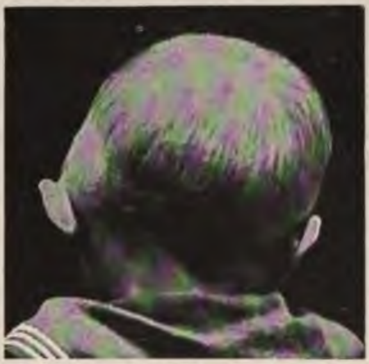

Fig. 192.—Periostitis and necrosis of the petrous portion of the temporal bone after otitis media, in a boy three years of age. The presence of pus beneath the periosteum produces the characteristic appearance of the ear being pushed outward from the side of the head (Frühwald).

veins which traverse canals from the meatus into the mastoid cells.

Pathology.—Koerner divides the suppurative processes within the mastoid into: 1, empyema; 2, softening and dissolution of the bony substance; 3, necrosis. Empyema is restricted to suppuration within the cell spaces without involvement of their bony walls. This condition frequently occurs on the third or fourth day of acute otitis, and recovery usually results without destruction of bone if there is free drainage through the tympanum. Dissolution of bony substance is brought about by swelling of the inflamed mucous membrane and periosteum lining the cells which finally completely fills them. A further increase takes place at the expense of the bony septa which soften and disintegrate, and a large amount of pus is usually poured out by granulation-like tissue which escapes through the tympanum. This process may invade the diploë or break through the mastoid cortex.

Necrosis resulting from acute purulent otitis media is more frequent in young children than adults, in whom it is not unusual to find a sequestrum during a mastoid operation. However, necrosis is much rarer than the former condition, which is sometimes, even at present, called caries. Necrosis is a slower and usually less painful process than caries. It may follow scarlet fever; hereditary syphilis and tuberculosis are said to be predisposing causes. The symptoms are at first similar to caries, but perforation of the cortex occurs earlier, when the parts assume the appearance shown in Fig. 203 as the result of pus beneath the periosteum. In tubercular adults the process often runs a chronic course, months or even years being required for the sequestrum to become separated. If operated upon before this occurs the air cells will be found empty or partly filled with a thin fetid pus, and mucous membrane and bone are pale and bloodless. It is important in operating on such cases to produce a bone ound that bleeds from its entire surface. wise it is probable that it has not extended beyond the necrotic area and that a sequestrum will form and require removal before the wound will heal.

In most chronic cases the mastoid antrum becomes filled with cholesteatomatous masses, thus isolating the mastoid cells from the tympanic cavity. *Active mastoid complications* during chronic suppuration of the middle ear frequently manifest themselves during an acute exacerbation of the middle-ear disease, with the result of producing an acute inflammation of a limited area of bone in the center of a sclerosed mastoid.

Caries or necrosis of the mastoid may extend inward and involve the lateral sinus, producing phlebitis, thrombosis, embolus, and their consequences. The middle fossa of the skull may also be penetrated and an abscess produced beneath the dura mater, a local pachymeningitis preventing further extension of the disease; or meningitis, both at the base and convexity of the brain; or brain abscess may occur.

Symptoms.—In acute cases the first symptom is intense pain, involving the mastoid and often the whole side of the head. The patient's face assumes the expression of abject woe. He eats little and sleeps less. There are tenderness on pressure over the mastoid, fever, and in most cases swelling and congestion of the upper posterior part of the meatus. In the more chronic form of the disease the patient is sometimes remarkably free from pain, almost the first symptom to which the surgeon's attention is called being congestion of Shrapnell's membrane, with swelling at the inner upper posterior part of the meatus, over the mastoid, or of the neck below the ear. Especially in children the external cortex of the mastoid may be penetrated early in the disease and the pus find its way underneath the periosteum. Under such circumstances the whole auricle, when seen from the rear, appears as if pushed out from the side of the head (Fig. 192).

A symptom of considerable diagnostic importance is *sudden cessation of discharge* from the meatus in the course of an acute otorrhea. It is probably caused by lack of sufficient drainage from the attic and antrum. If the discharge is not re-established within a few days, mastoid symptoms requiring operative interference generally manifest themselves. Granulations protruding through a perforation should be removed to secure better drainage. If pus exudes through a tit-like mass of swollen tissue on Shrapnell's membrane, the mass should be snared or cureted away, as very often these procedures are sufficient to secure rapid subsidence of mastoid symptoms.

In *cases requiring operation* the temperature is not a very reliable guide. In some cases it may be very little if any above normal. Pain on pressure over the antrum or at the mastoid tip may disappear. However, when in conjunction with tenderness on pressure over the antrum, which has been present for some days, there is swelling of the posterior wall of the meatus close up to the drum-head, so that a portion of Shrapnell's membrane is hidden, an operation should no longer be delayed, as such cases rarely or never recover without it. However, when the large cells at the tip of the mastoid are principally involved there will be no bulging of the canal, but nevertheless an operation is imperative. In making pressure over the antrum the observer should insert his finger at a level with the superior border of the meatus into the angle made by the junction of the auricle with the mastoid and press upon the bone in a direction backward and inward, being careful to move the auricle as little as possible, so as not to mistake the pain commonly caused in acute suppuration of the middle ear by movements of the auricle for bone tenderness over the antrum.

A small lymphatic gland is found upon the surface of the mastoid about ½ inch posterior to the meatus. Tenderness of this gland should not be mistaken for the bone tenderness of mastoiditis. Should this gland become infected and break down as the result of furunculosis of the canal or other causes, the pus will be beneath the skin and not beneath the periosteum, and consequently the auricle will not, when seen from the rear, appear pushed out from the side of the head. Such superficial abscesses simply require opening and not a mastoid operation.

Persistent tenderness of the mastoid tip and swelling of the tissues of the neck behind and below the mastoid indicate the presence of pus in the digastric fossæ as the result of suppuration of the large cell at the tip of the mastoid. Usually the median bony wall of this cell is thinner than the external cortex and breaks down more readily. In such cases the entire tip of the mastoid should be removed at the mastoid operation and the abscess cavity in the tissues of the neck laid freely open.

If a bacteriologic examination of the discharge from the meatus shows the presence of streptococcus, Friedländer's bacillus, or the encapsulated streptococcus, it is wise to operate earlier than if staphylococci only were present. A blood count should be made, but only in a few doubtful cases will an increase in the polynuclear neutrophils prove a safe guide when suppurative lesions of other parts of the body can be excluded. A negative blood count should not deter the surgeon from opening the mastoid should the symptoms manifestly require it.

Atypical cases are those where the disease progresses without well-marked symptoms—the so-called "latent mastoiditis." The onset, corresponding to the invasion of the middle ear, may be so slight as not to be perceived by the patient, or there may be a tonsillitis of a day or two's duration, followed by dull pains in the ear and impaired hearing. The pain soon subsides, and the patient forgets that he has had any trouble until after a time, varying from two or three weeks to several months, when he is suddenly seized with severe pain in the mastoid. Examination at that time will show pronounced mastoid tenderness on pressure, usually at the tip. The subjective pain, however, may radiate over the entire side of the head. The drum-membrane will appear normal in color, or there may be a slight lack of luster, and possibly injection of the malleus handle. In the majority of cases there is *impaired hearing*, which is only incidentally the case in hysteric mastoiditis, mastoid neuralgia, or in the pain referred to the mastoid in sclerosis (Fig. 191). The appearance of the drum-head is often normal or nearly normal both in latent mastoiditis and mastoidalgia, but tenderness on pressure is persistently present either over the antrum or the tip in latent mastoiditis. In some cases comparison of the percussion note of each mastoid, transillumination, or the *x*-ray yield valuable information. In doubtful cases there should be no hesitancy in opening the mastoid cells. The drum-head does not break down because of the mild virulence of the bacteria present in these cases or the possibility that the drum was thick and abnormally resistant. The fact that mastoid abscess with intracranial complications may occur months or even years after a suppurating ear has apparently healed is probably due to some infective focus of pus in the mastoid cells which remains latent. Especially in diabetes, but also in influenza, pneumonia, typhoid, and the exanthemata rapidly extending suppuration and softening of the bone may occur without pain, fever, or other marked symptoms. Such cases are most common in diploëic mastoids with a cortex sufficiently thick to prevent great tenderness on pressure over the diseased area and the process may extend to a general osteomyelitis beyond the limits of the temporal bone or meningitis or sinus thrombosis.

The *x*-ray is useful for defining the position of the lateral sinus. Normal mastoid cells transmit the ray better than slightly inflamed cells, and these better than cells filled with granulation tissue. If the walls of the cells are broken down by the necrotic process the negative shows an exceedingly dull area looking like an irregular foramina. Abscess in *the brain* transmits the ray to about the same degree as the surrounding tissue and hence the abscess cannot be differentiated in most cases.

In chronic otitis if the plates show only involvement of the tympanum and antrum there is a chance of recovery without operation; but a dense black shadow in the neighborhood of the antrum indicates cholesteatoma, and also if the cells about the antrum are involved a radical operation is indicated. If a sclerotic process has destroyed all the cells in the inferior part of the mastoid, only as much of the mastoid should be removed as is needed for working space in the antrum and tympanum.

Treatment.—When there is congestion of the posterior portion of Shrapnell's membrane and swelling of the neighboring tissues of the meatus, a free incision through Shrapnell's membrane and the swollen tissue will sometimes abort the attack (see p. 432). The mastoid process should be thickly covered with an ointment of 20 per cent. ichthyol in lanolin. The parts should then be covered with waxed paper and bandaged in order to prevent soiling the patient's clothing or bed-linen.

Pain is best combated by the application of dry heat by means of a hot-water bag. If absolutely necessary, an anodyne should be administered. Pain often can be relieved entirely for days by the application of cold to the mastoid process, either in the form of an ice-bag or Leiter's coil. However, this method is becoming less popular, as cold does not control the suppurative process, but simply masks its symptoms. The application of heat is the better treatment.

With the object of promoting the reaction of inflammation, 1 : 5000 hot bichlorid irrigations every hour have been made; and for the same purpose, Bier's treatment by constriction of the neck with an Esmarch elastic band applied only sufficiently tight to produce slight constriction of the neck, but no pain or discomfort, has been used. The bandage is applied four times in twenty-four hours with intervals of two hours between the applications, and the foot of the bed is slightly raised.

Painting the mastoid process with iodin or cantharidal collodion renders the skin so sore that it is difficult to determine whether tenderness on pressure is the result of the counterirritant or inflammation of the bone. Although a favorite method of treatment with the aurists of half a century ago, it is doubtful if counterirritation over the mastoid ever accomplished an appreciable amount of good. The writer has been called in consultation to see 2 cases of erysipelas apparently resulting from the application of cantharidal collodion over the mastoid. One of these cases, an old man with advanced chronic Bright's disease, proved fatal.

If, notwithstanding the application of ichthyol over the mastoid, dry heat, and the systematic treatment of the tympanic suppuration, the tenderness over the mastoid is not relieved, and pain, sleeplessness, and loss of appetite increase, it is necessary to operate.

The *prognosis* in uncomplicated mastoiditis is favorable. The major portion of cases recover with or without operation. The mastoid tenderness occurring in a large proportion of cases of acute suppuration of the middle ear within a few days of the onset of the disease commonly disappears within a short time as the result of treatment. The more severe forms of the disease occurring later, providing there is no swelling of the tissues at the inner upper portion of the canal, frequently recover without operation if properly treated, if the infection is not due to the presence of streptococci or the result of grip. The prognosis in scarlatina, tuberculosis, diphtheria, etc., is, of course, more uncertain with or without operation.

However, an early mastoid operation subjects the patient to practically no risk, and when in doubt as to the advisability of operating, the patient's interests, both as regards the risk of life and the integrity of the organ of hearing, will be conserved by giving the benefit of the doubt in favor of the operation. Even if the surgeon has the mortification at the operation to chisel through absolutely normal bone to an antrum but slightly inflamed, there is usually a rapid cure of the otorrhea, and such procedures may be considered as similar to the exploratory incisions of the general surgeon.

Technic.—The instruments required for the performance of the mastoid operation are scalpels, 6 hemostats, 2 Jansen's dilators (Fig. 196), 3 bone-gnawing forceps (Figs. 194, 195), 3 bone gouges (Fig. 198), a mallet, bone curets (Figs. 193, 197), periosteal elevator, grooved director, and a probe.

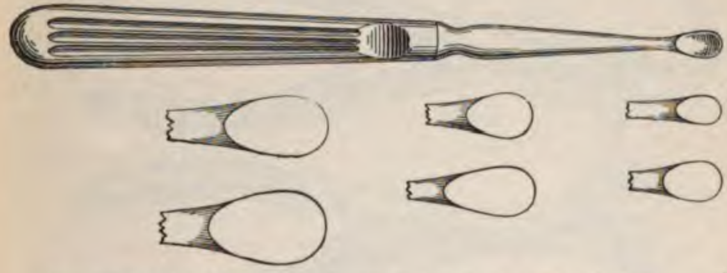

Fig. 193.—Whiting's mastoid curet. There are several sizes of this instrument manufactured. The medium size is the most useful; but during an operation the largest and smallest sizes should be on the instrument table, as they are occasionally required.

While opening the mastoid is generally performed for liberating the contents of a septic cavity, it should be done under antiseptic precautions. The instruments should be sterilized by boiling them in a 2 per cent. soda solution and the hands of the operator and those of his assistants disinfected in the usual manner. The patient's hair should be shaved off for a distance of about 2½ inches above and behind the ear to be operated upon. The skin covering the field of operation should be disinfected in the usual manner and the auditory canal syringed with warm bichlorid solution. These preparations of the patient for operation are better made previous to giving the ether. If the patient's hair is long it should be covered by a towel wet in bichlorid solution or a rubber cap.

If the drum-head has not been perforated during the course of the disease, it is best to preface the operation by an incision around the posterior periphery.

An incision is made through the skin to the bone from the tip of the mastoid to a point above the helix. The incision should be close to the insertion of the auricle. In children this incision should be made somewhat deliberately, with the edge of the knife rather than its point, so that there will be no danger of thrusting the knife-point deeply into a dehiscence of the bone. In infants the incision should be far enough back to avoid injuring the facial nerve (Figs. 184, 185). In adults the tip of the mastoid should be located with the end of the index-finger of the left hand and the point of the knife thrust at once through skin and periosteum into the bone. Maintaining firm pressure with the knife-point against the bone, the incision is continued upward around the auricle to stop at a point just short

Figs. 194, 195.—Hartmann's curved rongeur forceps. Four or more sizes and kinds of rongeur forceps are convenient for mastoid operations and opening the cranial cavity. A fairly practical outfit consists of Hartmann's curved, half-curved, and angular mastoid rongeur forceps, Jansen's small double curved forceps, and Keen's craniotomy forceps.

of the temporal artery, the exact position of which has previously been located with a finger-tip of the left hand. If the incision is made in this manner it will cut through the periosteum the entire length of the cut.

After the incision has been made several little spurting arteries will require clamping with hemostats by the operator or his assistant, and if the parts are brawny and swollen there will probably be a somewhat profuse venous hemorrhage from all parts of the wound, which will be lessened if the head of the operating table is slightly elevated. It can be controlled by the application of hot water or may be disregarded until the periosteum is separated from the bone, as it will cease after Jansen's dilator has been applied. If the mastoid process is large it may be desirable to secure additional space by making an incision about 1 inch in length at right angles to the original incision from the center of the auditory meatus toward the occipital protuberance. The presence of this second incision not only secures additional space, but has the advantage that the two posterior triangular flaps fall away from the bone and do not require the use of a dilator to hold the wound open.

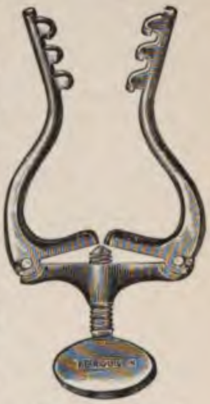

Fig. 196.—Jansen's dilator.

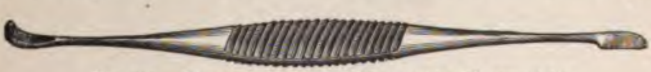

Fig. 197.—Gleason's double-end bone-curet with curved tip.

The periosteum should be separated from the bone with every precaution to avoid tearing it. It peals off from the bone very readily except where the bone is rough, at the tips of the mastoid, where the sternocleidomastoid muscle is attached. Here some patience and skill are necessary to avoid tearing; the best instrument for the purpose being the hoe-shaped periosteum elevator of Langenbeck or one of its modifications.

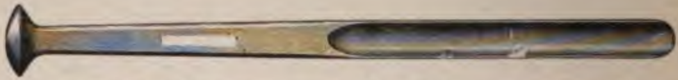

Fig. 198.—Alexander's mastoid gouges. These instruments are marked according to their width in millimeters, 14, 10, 8, 4 are the most useful sizes; similar chisels are made, but are not as useful as the gouges.

As soon as the periosteum has been separated from the bone, Jansen's dilator (Fig. 196) is inserted in the wound.

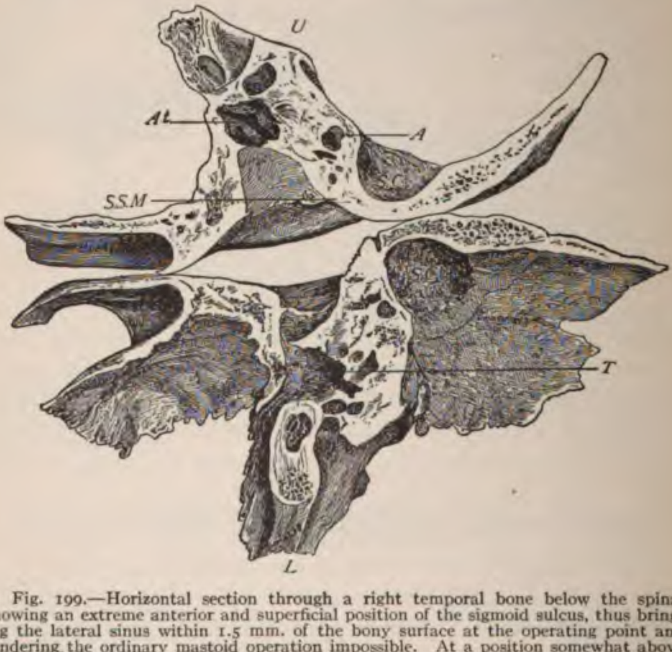

Fig. 199.—Horizontal section through a right temporal bone below the spina, showing an extreme anterior and superficial position of the sigmoid sulcus, thus bringing the lateral sinus within 1.5 mm. of the bony surface at the operating point and rendering the ordinary mastoid operation impossible. At a position somewhat above the operating point the sulcus is less than ½ mm. from the bony surface: *U*, Upper, *L*, lower portion of the specimen; *S,C*, sigmoid sulcus; *T*, tympanum; *At*, attic; *A*, small antrum; *S.S.M*, spina suprameatus. (Author's specimen.)

As the instrument is opened by means of the thumb-screw the wound becomes widely dilated and the pressure on the soft parts is sufficient to cause all hemorrhage to cease. Two of these instruments should be used, one at each extremity of the wound. The hooks of the instruments should be kept closely in contact with the bone as the blades are opened in order to grasp all of the tissues efficiently.

When the surface of the mastoid has been uncovered by the separation of its periosteum, it should be inspected carefully with a probe for the presence of any sinus or soft spot leading to an abscess cavity. If such a sinus is found it should be explored with a probe passed in the direction of the antrum and the softened cortex of the mastoid removed with a curet (Fig. 193) or bone forceps (Figs. 194, 195), used in such a manner as not to endanger the lateral sinus (Figs. 199, 200).

When the cortex has been sufficiently removed it may be found that the entire mastoid is a cavity filled with pus and pulpy granulations, every trace of cellular structure having disappeared. This condition of affairs is most likely to occur in large-celled pneumatic mastoids. The pulpy granulations and débris should be scraped away with the curet until firm normal bone is encountered. However, the curet should be used with gentleness and judgment in positions where the lateral sinus is likely to be encountered, so as not unnecessarily and unexpectedly to expose or wound this important vessel. The position of the mastoid antrum should also be located, and when working toward it with the curet the position of the aquæductus fallopii (Figs. 126, 127, 182, 202) should be borne in mind, so as to avoid danger of cureting away a part of the facial nerve.

The floor of the mastoid antrum lies just behind and below the spina suprameatus (Fig. 200), in a direction parallel to the bony meatus. If the operator is in doubt as to the direction of the bony meatus, it is permissible to insert a probe between the bony and membranous meatus so as to be absolutely sure as to the proper direction in which to continue the use of the curet or the chisel. Not

infrequently after the abscess cavity in the mastoid has been cleansed there will be found a small opening into the antrum, if, indeed, any exist large enough to permit the passage of a probe. The bone in this locality is usually soft enough to permit it being readily scraped away with the curet, but if not, a gouge should be used in the following manner: The edge of an 8 mm. gouge with its convexity forward is placed upon the bone about 2 mm. posterior to the superior suprameatus and struck one or more sharp blows with the mallet in such a manner that it penetrates the bone to a considerable distance *parallel to the ca*
The gouge is then placed just beneath the linea

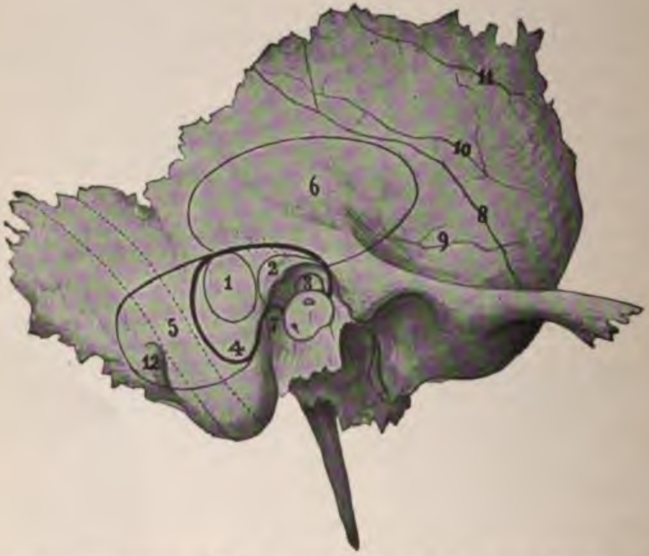

Fig. 200.—Right temporal bone, showing: 1, Opening the antrum after Schwartze; 2, point where the chisel is first inserted in removing the posterior wall of the meatus, after Wolf; in the radical mastoid operation—in this space is the spina suprameatus; 3, the same, after Stacke; 4, portion of mastoid process removed in same operation; 5, exposing the sinus and cerebellum; 6, exposing the cerebrum (temporal lobe); 7, spur, sometimes mistaken for the spina suprameatus; 8, middle meningeal artery; 9, second temporal fissure; 10, first temporal fissure; 11, fissure of Sylvius; 12, mastoid foramen. (Brühl and Politzer.)

slightly posterior to the meatus and struck with the mallet so that the chisel penetrates the bone in a direction toward the antrum; that is, slightly downward, inward, and forward. The triangular space of bone thus outlined corresponds with the upper portion of Macewen's triangle and is removed layer by layer with the gouge from behind forward until the antrum is opened. The operator can assure himself that it is certainly the antrum that is opened by passing a probe forward and inward through it into the attic. Fluid syringed into the antrum should appear in the meatus unless the aditus or attic is filled with granulations or the drum-head is not perforated. Should this be the case, they should be removed by means of a small curet (Fig. 178), being careful not to dislocate the incus during the procedure. However, should it prove impossible to syringe from the attic into the meatus, no especial harm need be apprehended.

Formerly, when the main abscess cavity had been thoroughly cleansed and a free communication established between the mastoid antrum and the external wound, the operation was considered complete. The larger proportion of cases operated on in this manner make an uneventful recovery and the resulting scar or deformity is inconspicuous. However, there are often a few cellular spaces above the meatus in the root of the zygomatic process, so that in cases where the operation results in the formation of a discharging sinus, the fistula frequently leads to one of the cell spaces that was not thoroughly opened at the time of the operation. Hence the disposition has been to make the bone wound larger than formerly by chiseling away the overhanging edge of bone above and behind the meatus at the root of the zygoma. Not only are all cell spaces, if present in this locality, by this method of operating removed, but the mastoid antrum is thoroughly exposed and becomes the bottom of a shallow cup-shaped from which exuberant granulations can readily and thoroughly be scraped away. All cellular structures should be removed by a curet rotated on its long axis until every portion of the bone wound is firm and hard to the touch of a probe which should be frequently applied during the curetage to be certain that the cranium has not been opened inadvertently and the dura exposed. As the cells overlying and posterior to the compact bone of the sulcus of the sigmoid sinus are removed the convex outer surface appears bulging into the bone cavity.

The wall of the bony external meatus should not be interfered with or collapse of the cartilaginous portion will occur when healing is complete.

In the tip of most mastoid processes there usually is a large cell even when the bone is of the small-celled diploëtic type (Figs. 187–190). It is best in all cases, therefore, to remove the cortex of the mastoid tip and thoroughly expose this large cell, if present, to inspection. If it be filled with pulpy granulations, these should be scraped away until the normal bone beneath has been thoroughly cleansed and exposed. In a small percentage of cases abscess of the large cell in the tip of the mastoid results in *perforation* through the median wall and the gravitation of pus into the digastric fossa and beneath the sternocleidomastoid muscle into the deeper tissues of the neck. Under these circumstances it is necessary to remove the entire tip of the mastoid and thoroughly expose the abscess cavity. The incision through the skin should be lengthened along the anterior border of the sternocleidomastoid muscle, and the attachment of the muscle to the end and median surface of the tip severed with scissors held as close to the bone as possible, after which the tip is very readily removed with the rongeur forceps (Figs. 194, 195). Newmann removes the tip with a bone gouge which is placed vertically on the mastoid at the lower border of the meatus and struck a sharp blow with the mallet. This process is repeated at the posterior border of the tip and its fracture is complete. The tip is then seized with forceps and subluxed outward, the muscle-fibers being cut away with scissors. Instances where the median surface of the large cell at the tip of the mastoid is perforated, with the result of the gravitation of pus into the digastric fossa and the deeper tissues of the neck, were first described by Bezold, and are hence frequently referred to as Bezold cases. They are characterized by a brawny swelling below and behind the mastoid, and movements of the neck are extremely painful to the patient. Not only is it necessary to remove the entire tip of the mastoid in such cases, but the abscess cavity in the tissues of the neck should be thoroughly laid open by a free incision through the skin. The sternocleidomastoid is attached not only to the tip of the mastoid process, but to the base of the skull posteriorly, and severing its attachment to the mastoid does not apparently impair its functions. However, except in Bezold's cases, it is manifestly not absolutely necessary as a mere matter of routine to remove the entire tip of the mastoid and expose the digastric fossa.

If no softened spot or sinus is found upon the surface of the mastoid bone after denuding it of its epithelium, it will be necessary to make an opening by means of the mallet and chisel. For this purpose the spina suprameatus or spine of Henle should be carefully located and preserved during the subsequent procedures of the operation to serve as a landmark. Some portion of the mastoid antrum will be found at a depth of from 12 to 22 mm. in a direction parallel to the meatus, immediately behind the spina suprameatus, in a space called the mastoid fossa, the suprameatal triangle, or triangle of Macewen, which is bounded above by the linea temporalis, in front by the posterior wall of the meatus, and behind by the remains of the squamomastoid fissure of infants (Figs. 184, 186). If the latter landmark is not readily discernible an imaginary line drawn from the parietal notch to the tip of the mastoid will answer the purpose. This line represents the course of the sigmoid sinus, and in most temporal bones there is a decided bulging of the mastoid surface over it. If at a depth of 15 mm. or about ⅝ inch when chiseling through dense bone the antrum is not opened, the operator should proceed with great caution to avoid injuring the facial canal or entering the cranial cavity, as the antrum may be small and easily overlooked. In some instances (Fig. 199) the lateral sinus is much further forward than usual, and to avoid injuring it the operator must keep as close to the meatus as possible. Where the drum-head and ossicles are partially destroyed, Stacke's protector (Fig. 201) or a silver probe with its tip bent at a right angle may be carried through the canal into the vault of the tympanum and held in such a position as to serve as a guide. If the chiseling and cureting be continued in the right direction within the triangle of Macewen, that is, from behind forward and from below upward, parallel to the canal and linea temporalis, there is little danger of wounding any important structure before the probe is encountered. When chiseling through sclerosed bones (Fig. 101), even though no cell structure or pus, but only softened bone in the region of the antrum is encountered, the relief of all mastoid symptoms usually follows the operation.

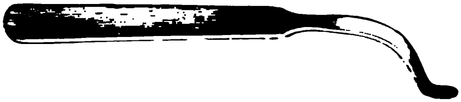

Fig. 201.—Stacke's protector.

After-technic.—After the operation is completed the wound and auditory meatus should be irrigated with warm sterile water and thoroughly cleansed. The wound may be allowed to fill with blood-clot or may be dressed by the en method. The forr the advantag ing aling in ten days i six weeks the other method, but is only applicable in cases where the operator is certain that he has secured an absolutely clean wound. The bone wound is allowed to fill with blood-clot. The upper and lower angles of the skin wound, including the periosteum, are carefully brought together with one or two sutures. A very small cigarette drain, made by inserting sterile gauze into a piece of catheter rubber which has been slit spirally, is then inserted superficially and held in place by a suture through the skin. Sterile gauze, cotton, and a roller bandage complete the dressing, which is not disturbed until the third or fouth day should the temperature remain normal. The cigarette drain is then removed and the dressing reapplied. Should the blood-clot become infected and break down, the sutures are removed, the wound cleansed with sublimate solution, and treated by the open method, which in a considerable proportion of cases is the preferable one from the start.

After the mastoid wound and meatus have been cleansed as described above, they are filled with 1 : 2000 sublimate solution and the wound packed loosely with iodoform gauze, one or two sutures being inserted at each angle of the wound if required and a roller bandage applied over sterilized gauze and cotton.

If the temperature remains normal and the patient comfortable after the operation the dressing should not be removed from the wound until the third day, after which the wound should be dressed every day or every other day. The parts should then be douched with a 1 : 5000 bichlorid solution, the wound again packed lightly with iodoform gauze, and sterilized gauze, cotton, and roller bandage applied, especially in infants. If the wound be packed too firmly during the first few days following the operation there is danger of injuring the facial nerve, with resulting transient paralysis of some of the facial muscles; later on the wound may with advantage be packed more firmly. In some cases the wound does better if, after thoroughly cleansing, it be dusted with boric acid and packed either with sublimate or sterilized gauze. This is more especially the case if the lips of the wound appear sluggish and the exposed bone does not quickly cover itself with granulations. The presence of edema in the superficial tissues about the wound may render advisable the use of a wet sublimate dressing for from twenty-four to forty-eight hours. Sometimes exuberant granulations on the superficial edges of the wound will require removal with the curet or scissors, as the wound requires to be kept open until firmly healed from the bottom, a result that usually requires from three to six weeks.

Usually recovery from a mastoid operation is uneventful. Pain and sleeplessness on the night following the operation may require the use of a small dose of chloral and bromid of sodium or even an opiate. Usually the temperature is practically normal and the patient entirely comfortable on the morning following the operation. If the evening temperature for the first three or four days reaches 100° or even 101° F., it need occasion no anxiety. When the temperature remains normal for one or two days the patient may be allowed to sit up and move about in his room.

Persistent pain and sleeplessness with high temperature following the operation may be due to a slight attack of local periostitis or to the fact that all the foci of inflammation in the mastoid bone have not been reached by the chisel. The former requires that the dressings be kept moist with a 1 : 3000 bichlorid solution for three or four days; the latter may necessitate a secondary operation.

Accidents Occurring During the Mastoid Operation.—The middle cranial fossa or the posterior cranial fossa may be opened, and the lateral sinus exposed or wounded. One of the semicircular canals may be penetrated. The facial nerve may be wounded or divided.

Occasionally the middle cranial fossa extends downward a level scarcely more than ¼ inch above the meatus. It is better, therefore, not to do any *deep* chiseling in this locality until the mastoid antrum has been located. After this has been accomplished and the cavity thoroughly exposed, it is easy to locate the exact position of the floor of the middle cranial fossa by means of a probe. After the antrum has been explored with the probe, it is easy, without the slightest danger of entering the middle cranial fossa, to remove the superficial bone, including the spina suprameatus above and behind the meatus, in order to secure a flat wound. Any considerable portion of the bony meatus itself should not be removed, as it is followed by collapse of the cartilaginous meatus after healing. However, if the middle cranial fossa be opened and the dura exposed, it is not a serious accident, as the dura granulates like the other portions of the wound. It is perfectly justifiable when softened bone is found in the vicinity of the tegmen to thoroughly remove the diseased bone even if by so doing the dura is exposed, as by this procedure a small extradural abscess may be opened whose presence otherwise would not be suspected. Should pus be located between the skull and the dura, the opening in the bone should be made sufficiently large to secure ample drainage, but exploration with the probe between the bone and the dura should be undertaken with extreme caution and gentleness, because the dura ordinarily attaches itself about such an abscess cavity to the skull, thus isolating the suppuration from the rest of the dural surface and preventing a general infection. If the dura is punctured, the opening should be enlarged with scissors to the extent of $\frac{1}{2}$ inch to afford drainage and diminish the possibility of infection.

Opening the Posterior Cranial Fossa and Wounding the Lateral Sinus During the Mastoid Operation.—In diploëtic and small compact mastoid bones the lateral sinus often occupies a position more anterior and superficial than is normally the case. In the bone shown in Fig. 199 a careless operator might readily expose and open the lateral sinus with the chisel. In very rare instances the sinus is not covered by bone at all, but lies immediately beneath the skin and might be freely opened by the first stroke of the knife. However, even in extreme cases of anterior position of the lateral sinus, there is usually a sufficient space of comparatively soft bone between the hard bone covering the sinus and that of the meatus for a careful operator to work through safely to the antrum with a curet or gouge. The position of the lateral sinus is often apparent after the cellular tissue has been cureted away, a distinct oval elevation of hard bone gradually shaping itself into view. This elevation is the hard bony wall of the sigmoid fossa in which the lateral sinus lies. Should the bone be carious and soft it should be scraped away with the curet and the sinus exposed, because extradural abscess is common in this locality. When the lateral sinus is torn or cut during a mastoid operation it does not spurt like an artery, but a gush of blood wells out from the wound, pulsating with each heart-beat as it flows. The lightest pressure of the finger upon the bleeding sinus sometimes causes the hemorrhage to cease.

When the lateral sinus is accidentally wounded during a mastoid operation a small piece of iodoform gauze should be placed on the sinus and held in position by the finger of an assistant and, if possible, the operation completed. The wound should then be firmly packed with iodoform gauze in such a manner as to control the hemorrhage, and the edges of the wound approximated over the gauze by means of sutures and a firm dressing applied. The iodoform gauze packed within the wound is not disturbed until about the fifth day, when a part of it is removed and replaced by fresh gauze. The gauze immediately over the bleeding sinus is not removed completely until about the seventh day. If possible these changings of the gauze within the wound should be done without removing the sutures, or at least all of them. On about the eighth day all of the sutures are removed and the wound dressed in the ordinary manner, because by that time the sinus probably has healed or a firm clot has formed that prevents the escape of blood. Cases in which the lateral sinus has been accidentally wounded generally do well and make an uneventful recovery.

Opening the Horizontal Semicircular Canal and Wounding the Facial Nerve.—The position of the horizontal semicircular canal and the facial nerve is shown in Figs. 126, 127, 202, and 216. The aural portion of the facial nerve may be divided into a horizontal and vertical portion (Figs. 126, 127). The horizontal portion is embedded in a ridge of bone just above the oval window. The horizontal semicircular canal lies just above posteriorly. Both of these structures are embedded in ridges of extremely hard bone. These ridges can frequently be seen in the radical mastoid operation as soon as the attic is well exposed, and hence the exact position of the nerve located. The simple mastoid operation, even when it is sufficiently complete to convert the antrum into a shallow cup in the bottom of the bone wound, does not expose the bony ridges containing the horizontal semicircular canal and the horizontal portion of the facial nerve. However, these structures lie so high up and so far forward that there is little danger of injuring them, except by a careless operator. Ordinarily the ridges of bone containing the horizontal semicircular canal and the horizontal portion of the facial nerve are sufficiently hard and thick to offer great resistance to an instrument, but occasionally the bone is very thin over the horizontal part of the facial nerve or may in part be lacking, so that the nerve lies just beneath the mucous membrane. Hence, if at the close of a simple mastoid operation the aditus and attic are found to be full of exuberant granulations and the small curet (Fig. 178) is used to remove them, it should be employed with great gentleness whe [illegible] r median wall of the aditus.

However, it is the vertical portion of the nerve that is most liable to injury during a mastoid operation. Because of the oblique position of the membrana tympani the annulus approaches in some instances as close to the nerve as ½ mm. at a position opposite the malleus tip. The operator should observe considerable caution in removing much bone in this locality.

When the bone forming the facial canal is necrosed it is difficult to avoid injuring the nerve during its removal, and hence, if the nerve is partially paralyzed before an operation, it is well to caution the patient that the operation may fail to relieve this condition or even make it worse. A simple bruising of the nerve during a mastoid operation is followed by transient paralysis of the muscles of one side of the face. The paralysis is usually worse in the muscles of the lower portion of the face because that part of the face is supplied by the more superficial fibers of the nerve. Cases of this kind and paralysis resulting from too tight packing of the mastoid wound end in complete recovery. It is stated that the nerve may be completely severed without causing permanent facial paralysis. The nerve also may be wounded at its exit from the stylomastoid canal which is at the anterior extremity of the digastric groove, posterior to the root of the styloid process, and immediately beneath the inner posterior wall of the external meatus. If these facts are borne in mind, the position of the nerve at its exit from the skull is readily located with the finger after the removal of the mastoid tip.

Radical Mastoid Operation, Exenteration of the Middle Ear.—So termed in contradistinction to the simple and complete mastoid operation; also tympano-mastoid in contradistinction to the meato-mastoid or Heath operation. The object of the procedure is to convert the middle ear into a skin-lined cavity, all parts of which are visible and easily accessible for the removal of accumulations.

Indications.—Welton mentions the following indications for the radical mastoid operation:

1. Persistence of pain in the ear or over the mastoid process. Permanent or intermittent attacks of vertigo, due to erosion of the external semicircular canal. Marked cerebral disturbance.

2. The existence of a fetid suppuration for a year or longer and when local treatment to the middle ear for a period of three months has failed to cure.

3. Frequently recurring middle-ear suppuration with preceding malaise, slight or severe headache, temperature, and mastoid tenderness.

4. Where the disease is not limited to the tympanum and where operation is prophylactic against fatal results coming without signs of pus retention or visible inflammation of mastoid.

5. Where pain and mastoid tenderness supervene upon cessation of discharge, to be relieved when pus begins to flow.

6. Chronic suppurative mastoiditis.

7. An onset of acute mastoiditis during the course of tympanic suppuration.

8. Fistula of mastoid bone.

9. Cholesteatomatous formation.

10. Labyrinthine vertigo in old healed suppurative cases.

11. Necrosis of bone shown by *x*-ray.

12. A sclerosing or rarefying osteitis where such condition produces periodic attacks of mastoid pain after all signs of active trouble in the ear have ceased.

13. A narrowing or complete stricture of the external auditory canal which would lead to pus retention.

14. Facial paralysis.

15. Tuberculosis causing the discharge.

16. Any intracranial or sinus involvement or the presence of an oncoming general septicemia.

17. Neuroretinitis or choked disk in a patient with chronic suppurative otitis media.

18. Where it is desired to take out life insurance.
19. In children when there is necrosis in both middle ear and mastoid cells.
20. Children from five up, with two years' suppuration, in whom there is increasing deafness.

After opening the antrum as in the simple mastoid operation the cartilaginous canal and as much of the periosteum as possible are separated from the bony canal by means of a small elevator. An incision is made through the loosened tissues as close to the drum-head as possible, and by traction forward upon the auricle the funnel-shaped mass is pulled out of the bony canal, exposing the tympanic structures clearly to view. A narrow strip of gauze is now passed through the cartilaginous canal from without inward and the ends tied together and handed to an assistant. The strip of gauze forms an efficient retractor for holding the canal and auricle forward out of the operator's way. The bone intervening between the meatus and the artificial opening is now chiseled away down to the annulus tympanicus. It should be borne in mind that the facial nerve approaches the annulus somewhat closely posteriorly on a level with the tip of the malleus handle, and the annulus should not be chiseled away below the level of the external semicircular canal. There yet remains the bony outer wall of the attic and aditus. This is weakened by chiseling with a narrow gouge the upper wall of the meatus until finally it is easily removed with a curet, the author's curet (Fig. 197) being convenient for this purpose. Its curved tip is introduced into the tympanum beneath the overhanging bone, which is rapidly cut away, not by drawing the instrument outward, but by rotating it in such a manner that the bone is cut alternately by the sharp anterior and posterior edges of the cup, the curved tip of the curet in the meanwhile preventing the instrument from becoming displaced. In order to afford a firm grasp upon the instrument while executing this maneuver the handle of the instrument between the cups is made very broad and roughened. The tendon of the stapedius muscle and the incudostapedial articulation are now severed and the malleus and incus removed. The cureting of the outer wall of the antrum and attic is continued until there is no overhanging wall of bone to prevent a clear view of the tegmen. It is important that no ridges of bone remain between the floor of the meatus and the mastoid wound. Such a ridge is conveniently chiseled away from behind forward with a gouge held at right angles to the axis of the canal; but the region of the facial nerve should not be encroached upon. The "hypotympanic space," or that portion of the tympanum below the level of the external bony meatus, is obliterated by cutting down the floor of the meatus with a 4 mm. gouge. The tip of Stacke's protector (Fig. 201) is first inserted into the hypotympanic space and held by an assistant. The operator then chisels away the bone toward the instrument, being careful not to encroach on the posterior wall of the meatus and injure the facial nerve. The mucous membrane at the mouth of the eustachian tube is also carefully rasped, or cureted away to secure obliteration of the tube mouth, which is accomplished by the growth of granulations during healing. However, no amount of cureting which would be safe in the eustachian tube will obliterate the tubal cells which are frequently present leading off into the bone. The position of the carotid canal should be borne in mind, as the use of cutting instruments at the tympanic tube mouth in a backward and downward direction is dangerous. The bony wound is flushed with cold bichlorid solution and firmly packed with iodoform gauze during the preparation of skin-flaps to check all oozing and permit of a thorough inspection of the tegmen, and the inner wall of the tympanum is searched for necrosed bone or a fistulous opening leading into the cranial cavity or the labyrinth.

Having exenterated the middle ear, a method is adopted for lining as much as possible of the large bone cavity with skin-flaps cut from the meatus and concha, to secure rapid epidermization and an enlarged meatus, to permit the free entrance of air, and facilitate the drying and removal of débris after healing. It should be remembered that these flaps must consist only of skin, and, before cutting them, tissue and cartilage must be dissected from the posterior and upper part of the meatus down to the skin. An assistant inserts a hemostat into the cartilaginous meatus, which, when opened, stretches the meatus. The flesh and cartilage is then somewhat easily removed with forceps and curved scissors. The skin of the meatus is now slit, by Panse's method, along its posterior surface to the concha, whence two right-angled incisions are made, one upward and the other downward, thus forming two quadrilateral flaps which are stitched to the periosteum and subcutaneous tissues with catgut in such a manner as to form a partial dermic lining for the middle-ear cavity and enlarge the meatus. Passow's modification of the Panse flaps is to make the incision ≻ shaped, so as to secure a short anterior flap which is bent sharply back and stretched into place after the meatus has been dilated by the operator's little finger. The uncovered space between these flaps may be allowed to heal by granulation or may be grafted at the time of the operation or ten days afterward by Thiersch's method. The wound behind the auricle is brought together by sutures through the periosteum and skin. A small cigarette drain is then placed loosely in the enlarged meatus and the parts protected by a dressing of gauze, absorbent cotton, and a roller bandage, in the same manner as after a simple mastoid operation. If the temperature remain normal, the wound is not dressed for three or four days, after which daily dressings perhaps will be required. At each dressing the meatus is either syringed lightly with a 1 : 5000 bichlorid solution or simply mopped dry and a fresh cigarette drain inserted. Should the skin-flaps fail to grow or the wound become infected, exuberant granulations may require removal with scissors or snare and the instillation of alcohol. Epidermization is greatly hastened by applications of a 10 per cent. ointment of scarlet red.

Körner's flap is made by two incisions, one at the postero-superior and the other at the postero-inferior border of the meatus, from its median aspect out to the concha; the resulting large quadrilateral flap is then reflected backward into the bone-cavity, partially lining it.

Ballance's flaps are made by means of an incision which extends from the median aspect of the meatus to the concha and then around the concha in the form of a shepherd's crook. The upper and lower flaps are secured by means of anchor sutures, two for the upper and one for the lower.

Causes of Failure After the Radical Operation.—Failure may be due to: 1. The anomalous structure of the temporal bone where the cellular structure leads to depths from which it is imprudent to remove it; in some instances into the sphenoid and occipital. 2. Incomplete operation: generally failure to remove the outer wall of the attic and antrum and completely open all cells. Epidermis grows with difficulty if at all over sharp edges of bone or into small cells with overhanging edges. 3. Failure to completely close the eustachian tube: so that with each cold mucopus is either blown or flows into the middle ear. 4. Retained secretions occasionally form cholesteatomatous masses which, if long retained, set up infection. 5. Neglect to watch the process of granulation and epidermization; so that strictures of the canal result from thin walls of epidermis or pockets result from the bridging over of spaces by epidermis. 6. Insufficient space to permit free access to the mastoid cavity from the canal as the result of a faulty management of the skin-flaps.

The last word has probably not been said as regards the value of complete exenteration of the middle ear as a treat-

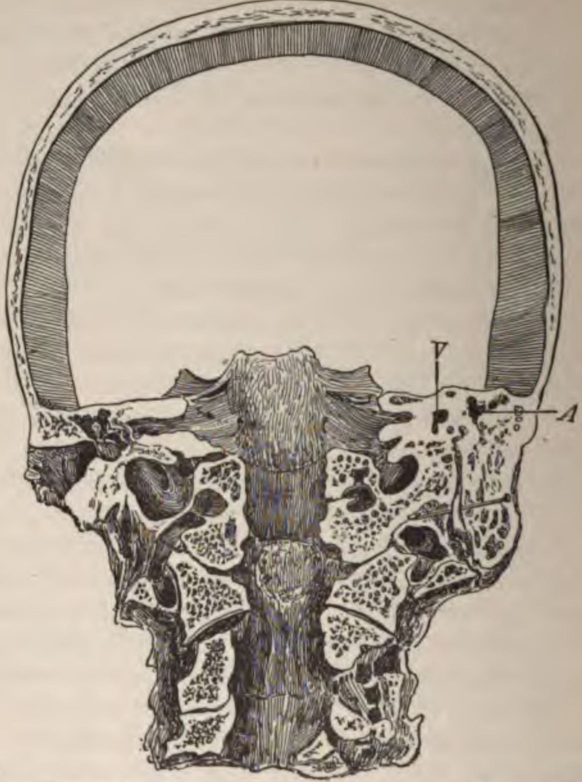

Fig. 202.—Vertical frontal section through the skull, anterior portion of the specimen seen from behind. The saw has passed through the spina on the right side and laid open the aquæductus fallopii through its entire vertical portion, showing the facial nerve, under which a pin has been passed. It should be observed that the nerve lies nearly vertical in this part of its course, while above and *external* to it is an opening into the most external portion of the horizontal semicircular canal. The anterior part of the antrum, *A*, has been opened, and also the vestibule, *V*, and the superior semicircular canal. On the left side the saw has passed through the posterior portion of the external and internal meatus, removing the posterior edge of the drum-head and the incus. The stapes still retains its position in the oval window. Below the tympanum is the bulb of the jugular vein. In comparing Fig. 202 with Fig. 203, note that the saw has passed slightly more anteriorly through the left ear of the specimen. (Author's specimen.)

ment of chronic otorrhea and the prevention of intracranial complications. It is urged that such complications do not occur except in a very small percentage of cases, and that chronic otorrhea not infrequently exists from early childhood during the entire life of the individual without greatly impairing his hearing or requiring more attention than somewhat frequent cleaning. That, on the other hand, besides the risk of complete exenteration, the patient's

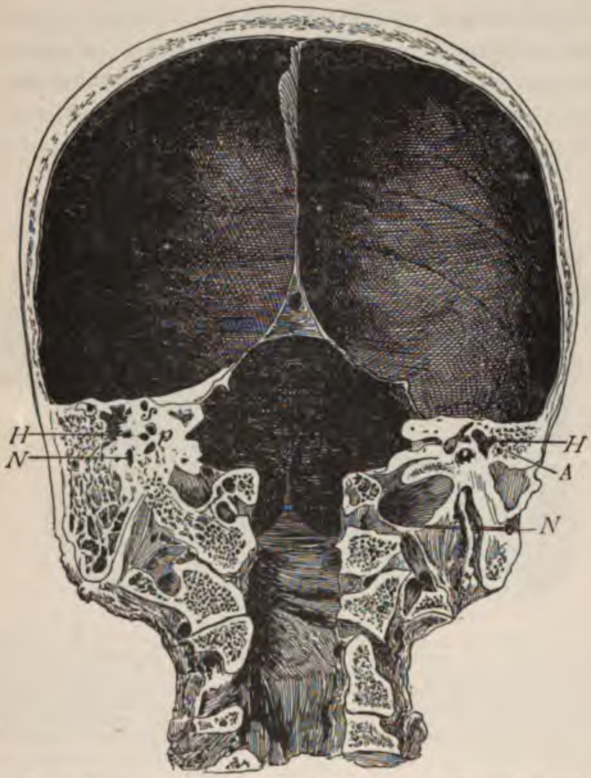

Fig. 203.—Vertical section through the skull, posterior portion of the same specimen as Fig. 202. On the left side the saw has passed just anterior to the aquæductus fallopii, and a pin has been passed under the facial nerve, *N*, at its exit from the stylomastoid foramen. Above is seen an opening made into the commencement of the vertical portion of the facial canal. Still higher up is a portion of the horizontal semicircular canal (*H*) laid open and occupying a position somewhat *lateral* to the facial nerve and median to the aditus (*A*). On the right side the section has passed through the anterior part of the antrum and is posterior to the facial canal, and has opened the horizontal semicircular canal at its most external part. (Author's specimen,)

hearing, if good before the operation, will almost certainly be impaired to the extent of inability to hear the whispered voice at a greater distance than 1 meter, and may be practically entirely lost, and in a majority of cases, if epithelium and other débris are not removed every few months, there will be recurrent otorrhea. Therefore, it would seem wise, where there is a large perforation of the drum-head and only the atrium affected, not to advise a radical operation, and in attic cases not until cleansing treatment faithfully carried out has failed to bring about a cure of the otorrhea. The operation is rarely justifiable in young children or on the ear of an adult upon which he mainly depends for hearing.

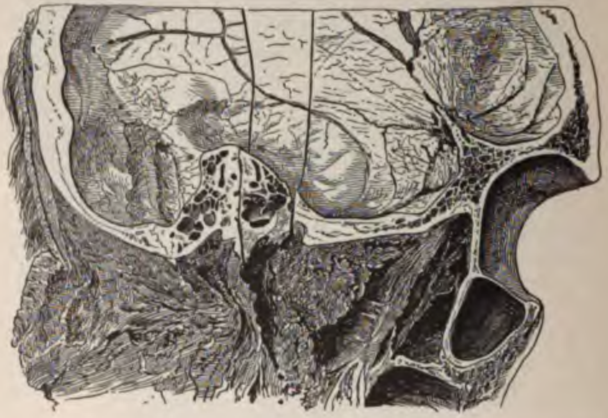

Fig. 204.—Vertical sagittal section through the tympanum; median aspect of the lateral portion of the specimen. The lower part of the membrana tympani is cut away by the saw and above the drum-head inclines outward at an angle of 140 degrees with the upper wall of the meatus. The malleus handle and the malleo-incudal articulation, as well as the descending process of the incus, are visible. The section passes through the canal for the tensor tympani muscle, so that the trochlea and tendon are shown. Above the tympanum portions of each of the semicircular canals are visible. (Author's specimen.)

In order to overcome the disadvantages of exenteration, Heath has advised a semiradical operation similar to the ordinary operation, including the employment of skin-flaps from the meatus and concha, which does not disturb the tympanic contents; on the theory that in most instances the eustachian tube is able to drain the discharges of the attic and tympanum, but not also those from the mastoid cells. At the time of the operation the attic is thoroughly cleansed through the aditus by means of syringing and currents of air from the syringe, so that cholesteatomatous scales of epithelium and even small pedunculated polypi are blown from the attic and appear in the canal, whence they are easily removed. Ultimately the aditus is closed posteriorly by cicatricial tissue after cessation of the otorrhea, without the impairment of hearing so common after a complete exenteration. In some cases regeneration of the drum-head occurs either wholly or partly.

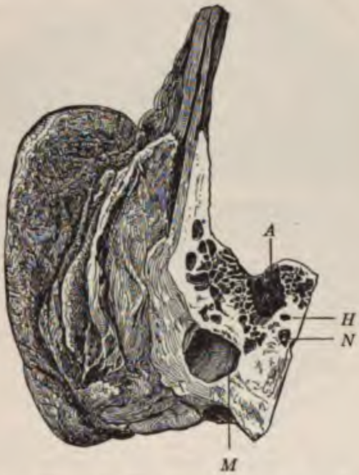

Fig. 205.—Posterior surface of the portion of the ear removed by the two vertical frontal saw-cuts seen in Fig. 204. The external bony meatus has been laid open only at its most external position. Above, the saw has passed through the aditus and posterior to the facial canal: *A*, Aditus, with its bony roof partly removed; *H*, horizontal semicircular canal; *M*, meatus; *N*, facial nerve.

When chiseling away the posterosuperior wall of the meatus and opening the attic the topographic relation of the posterior wall of the meatus to the descending portion of the facial nerve should be borne in mind. The student should study the topographic relation of the structures involved in operations upon the middle ear by preparing a large number of frontal, sagittal, and horizontal sections of the ear. Such sections should be made not through a separated temporal bone, but while the bone is still in position in the skull. Injected heads, sawn in half through the sagittal structure and mummified by exposure upon the roof of a house for a few months, are very suitable fo making such sections. After the sections are made parts should be freed from fat by repeated soa

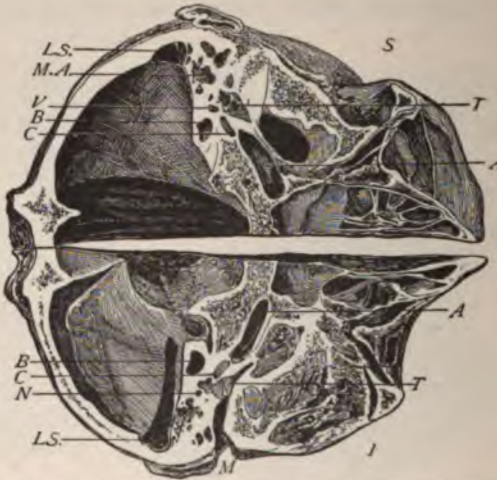

Fig. 206.—Horizontal section through the roof of the external meatus: *I*, Inferior portion; *S*, superior portion of the specimen; *M*, external auditory meatus; *T*, tympanum; *M.A*, mastoid antrum; *A*, carotid artery; *L.S*, lateral sinus; *B*, bulb of the jugular vein; *N*, facial nerve. In the lower half of the specimen is the handle and short process of the malleus, the saw having passed through the neck of the bonelet. The membrane slopes obliquely forward at an angle of 55 degrees with the axis of the meatus, and outward at an angle of 140 degrees with the roof of the meatus. The section passes through the oval window, so that the cavity of the vestibule (*V*), as well as the cochlea (*C*), is shown in the upper half of the specimen. Here also is to be seen the malleus head, the incus, the attic, and the mastoid antrum. The stapes has been removed by the saw. The bulb (*B*) of the jugular vein extends further upward than in most specimens. (*Author's specimen.*)

gasoline or benzine. By careful attention to this detail the specimens may be rendered almost devoid of smell, as the foul odor originates principally in the fat of the tissues.

The specimens may be further cleansed and bleached by placing them in the sun and spraying them from time to time with an atomizer containing hydrogen peroxid rendered slightly alkaline by the addition of liquor potassæ. After subsequent drying the soft parts should be preserved by applying to them several coats of bleached shellac varnish, which may be made to assume any color required to render the structure more natural in appearance by the addition of one of the aniline dyes. Each coat of varnish is allowed to soak well into the soft tissues in order to preserve them. However, specimens of a large section of the head prepared in this manner are rather too realistic to show indiscriminately to office patients, as by the skilful use of the aniline dyes they are made to look as if still bleeding and freshly severed from the body. Therefore, if it is found convenient to have a few specimens like Fig. 64, for example, to aid in the explanation to patients a proposed operation, it is better to coat such specimens with aluminum or bronze paint. The most useful sections for purposes of study are a vertical, frontal section through the spina suprameatus (Fig. 205), a vertical sagittal section through the floor of the tympanum (Fig. 204), a horizontal section through the roof of the meatus (Fig. 206), and a section parallel to the inner wall of the tympanum (Figs. 125–127). Besides making the sections through the middle ear, the student would do well to operate many times upon the cadaver before attempting any serious operation upon the ear of a patient.

INTRACRANIAL COMPLICATIONS OF OTIC DISEASE

Intracranial complications of otic disease from acute suppuration frequently are rapid and virulent. The infection long the lymph-sheaths of vessels or nerves, in the blood-current, or from one of four points: the labyrinth, by way of the internal meatus, duct, or aqueduct, probably the most common route in septic leptomeningitis, or by infection through the thinnest layers of bone about the middle ear. These are the tegmen of the attic and antrum, the wall of the cells overlying the lateral sinus, and the floor of the tympanum. Extradural abscess, abscess of the temporal lobe, and meningitis originate by way of the tegmen. Extradural abscess, cerebellar abscess, sinus phlebitis, and meningitis by way of the cells about the lateral sinus; and infection of the jugular bulb through the tympanic floor. Intracranial complications occur in the following order of frequency: extradural abscess, sinus thrombosis, brain abscess, septic meningitis. Three-fourths of the infections occur in the posterior fossa and only one-fourth in the middle fossa. Theoretically the existence of an uncomplicated intracranial disease produces well-defined symptoms, but practically it is rare to have one portion of the intracranial contents infected without complicating others and rendering exact diagnosis as to the principal lesion often impossible. No single symptom is characteristic. Optic neuritis frequently occurs early in leptomeningitis and later in sinus thrombosis, but may occur in purulent middle-ear disease without obvious signs of an intracranial complication, and in this condition vascular changes are so frequent as to amount to at least 25 per cent. There may be convulsions or exaggerated reflexes, as shown by Babinski's sign, which consists in extension of the great toe on touching the sole of the foot. Kernig's sign is probably the most constant, and stiffening of the muscles of the neck occurs in all inflammations of the contents of the posterior fossa. Sensory symptoms, photophobia, and hyperesthesia; sympathetic vasomotor disturbances, the tache cérébrale, and finally symptoms due to the death of nerve-cells, paralysis, anesthesia, and coma, may all be present in meningitis. The degree of purulence and the kind of bacteria in the cerebrospinal fluid obtained by lumbar puncture furnishes valuable information as to the extent and virulency of meningitis. When clear and sterile, only circumscribed inflammation is probable. Great purulency and streptococci or a mixed infection indicate a virulent diffuse meningitis, where operation would probably be useless, but slight turbidity and few bacteria do not indicate a hopeless condition.

Lumbar puncture is performed as follows: The patient either sits up or lies upon the side, with the back arched and the knees flexed against the abdomen. The spine of the fourth lumbar vertebra should be located (a line drawn from one posterosuperior spine of the ilium to the other passes across it) and the puncture made ½ inch to one side, at the level of its lower end. The needle should be inclined at an angle of about 45 degrees to the surface of the skin, and should be thrust in a distance of from 2½ to 3 inches. The most scrupulous asepsis must be observed. The spinal fluid flows readily, either in a stream when the pressure is high, or drop by drop if it is normal. In purulent meningitis it is cloudy and contains pus-cells; in tuberculous meningitis it is usually clear; in cerebral hemorrhage it may be bloody, but as admixed blood may be due to the injury of a vessel by a needle, the diagnosis should be made with caution. The quantity obtained varies from 2 to 3 to 80 or 90 c.c.—*i. e.*, from a few drops to 3 fluidounces.

Pressure symptoms, of which the most common is pain located in the frontal or occipital region, do not indicate the seat of the lesion. Vomiting in the initial stage is from septic absorption, but in the later stages results from pressure and is most common in cerebellar abscess. Restlessness, drowsiness, apathy, or moroseness, and in children intolerance of light are common. Pressure produces a slow pulse, and hence both in meningitis and abscess the pulse is rapid only in the i [illegible] alized symptoms, such as impairm [illegible] , and cerebellar ataxia occur when certain areas are involved and may be the result of pressure, inflammation, or actual destruction of the part.

Kernig's Sign.—In 1884 Kernig announced the impossibility of producing complete extension of the leg on the thigh, with the patient sitting and the thigh flexed at right angles to the trunk, when there is irritation of the meninges of the lower portion of the cord. In bedfast patients the thigh should be flexed on the abdomen, and if meningitis be present, complete extension of the leg will be prevented by contraction of the flexor muscles. Kernig's sign may be present in any form of meningitis, but its absence does not exclude localized meningitis.

Brudzinski's neck sign is said to be present in all types of meningitis. The head is forcibly flexed with the left hand while the patient is lying flat on his back, the observer keeping the chest from being lifted by means of his right hand. If the sign is positive, both legs will flex on the thighs and the thighs on the abdomen.

Examination of the blood in intracranial complications of mastoiditis may render valuable assistance. The blood is composed of fluid and corpuscular portions. The fluid portion is called the liquor sanguinis or plasma and yields on evaporation about 10 per cent. of solid matter, consisting of fibrinogen, serum, albumin, serum albumin, serum globulin, and salts, mostly sodium chlorid. The corpuscular elements consist of red cells or erythrocytes, white cells or leukocytes, blood-plaques, and hemoconia or blood-dust.

The chief function of the red corpuscles is to carry oxygen from the lungs to the tissues. In health their number varies from 4,500,000 to 5,000,000 to the cubic millimeter, and the percentage of their chief component, hemoglobin, from 85 to 95 per cent. A decided diminution in the number of red cells or in the percentage of hemoglobin in sepsis is proportionate to the virulence and duration of the infection. In simple anemia, where the proportion of hemoglobin is below

50 per cent., it is better to delay operations when possible until systemic treatment has corrected the deficiency.

The **normal coagulation time of blood,** as tested by the glass slide or Wright's coagulatometer, is from two to five minutes. In patients suffering from jaundice, hemophilia, or purpura, if coagulation does not occur in ten or fifteen minutes, it is best to avoid operations when possible until systemic treatment has brought about the normal coagulability of the blood in order to avoid troublesome hemorrhage. This can be accomplished in most instances by the administration of 5 gr. of calcium chlorid (Formula 47) every three hours for one or two days, or the injection of horse-serum.

Blood-plaques are small spheric bodies whose function is but imperfectly understood, but they are supposed to play an important part in the formation of a clot. In health they number from 108,000 to 500,000 to the cubic millimeter.

Hemoconiæ are small highly refractive bodies constantly present, about whose origin and function nothing definite is known.

Bacteriemia, or the presence of specific bacteria in the blood, is conclusive evidence of the nature of an infection, and it is possible to secure sometimes a nearly pure culture of the offending organism. According to some authorities the presence in the blood of the Staphylococcus pyogenes albus does not affect the prognosis, but the prognosis is grave when any other pyogenic bacteria are present. Positive results from blood-culture tests are said to be only found in otic cases when complicated by meningitis or sinus thrombosis, and the method is especially valuable when there is doubt as to the existence of a sinus thrombosis after a mastoid operation when the temperature remains high.

Leukocytes are of three groups, depending upon the staining qualities of the granules within the cytoplasm:

eosinophils stain best with acid anilin dyes; *basophils*, with basic dyes; *neutrophils*, with neutral dyes. There are two varieties of leukocytes: (1) Lymphocytes, large and small, without granules in the cell and without ameboid movements; (2) leukocytes with granular cytoplasm and ameboid movements. There are mononuclear leukocytes, a transition form between lymphocytes and polymorphonuclear leukocytes, polymorphonuclear leukocytes, and eosinophils.

Leukocytes, by their bactericidal or phagocytic action, protect the system from infection and assist the elimination of the products of inflammation, irritation, and tissue metamorphosis. In health their number varies from 5000 to 10,000 to the cubic millimeter. DaCosta states the proportion of the different leukocytes as follows:

VARIETY.	PER CENT.	NUMBER PER CUBIC MILLIMETER.
Small lymphocytes	20– 30	1000– 3000
Large lymphocytes and transitional forms	4– 8	200– 800
Polynuclear neutrophils	60– 75	3000– 7500
Eosinophils	0.5– 5	25– 500
Basophils	0.5	25– 500
	85–118	4250–11800

Leukocytosis is an increase in the proportion of white cells, generally as the result of an increase in the number of polynuclear neutrophils. Pus may be suspected when the percentage is over 75 per cent., but a lower percentage does not contraindicate a mastoid operation when clinical symptoms are present because the percentage indicates only the amount of toxins being absorbed. Sometimes all the varieties of leukocytes are increased in number. In health various causes may produce a temporary leukocytosis up to 10,000. Leukocytosis is said to be mild when the number of leukocytes is not above 16,000, and well marked when their number reaches or 25,000. de of ukocytosis indicate resistanc ion. *enerally* l resist moderate leukocytosis and a virulent infection in well-marked leukocytosis; but if the infection is so severe as to overwhelm the patient's powers of resistance, there will be a decrease (leukopenial) in the percentage of white cells.

These facts have an important bearing on the prognosis in the intracranial complications of mastoiditis, because if there is a decided leukocytosis present, it indicates that the resistance of the patient to the bacteria causing the infection is active, while a decided leukopenia indicates feeble resistance and an unfavorable operative prognosis. However, it should be borne in mind that bacterial infection does not produce leukocytosis unless the toxins resulting enter the blood in sufficient amount to exert a chemotactic action on the leukocytes, and the blood count is usually negative in chronic pus cavities. Hence, in uncomplicated tuberculosis of the ear or upper respiratory tract, there usually is no leukocytosis present. For the same reason, in malignant disease there may be no leukocytosis, or it may be present to the extent of 30,000 or even 40,000, but in septicemia from any cause the leukocytosis is not usually above 20,000. In leptomeningitis and sinus thrombosis there is usually either high leukocytosis or leukopenia.

Serous leptomeningitis begins as a general hyperemia of the pia and arachnoid, followed by a serous exudation. The dura and ventricles become distended by the exudate with resulting pressure symptoms.

Slight cerebral irritation, especially in children, probably meningitis, frequently accompanies acute inflammation of the middle ear. The symptoms are localized headache referred to the temporal or occipital region, which may be tender on palpation. Morning and evening fever is sometimes present and, in infants, convulsions. These symptoms may disappear within a short time as the result of purgation with calomel, the use of bromid of potash, and an ice-cap, or the pulse may become rapid, the temperature rise, the pupils cease to react to light, and hebetude with loss of consciousness occur. Under such circumstances immediate relief frequently follows lumbar puncture. An ounce or more of cerebrospinal fluid sometimes quickly flows from the cannula and pressure symptoms subside. Especially in children grave intracranial symptoms sometimes disappear within a few hours after the evacuation of pus from the mastoid antrum. Lumbar puncture may be repeated as often as necessary to afford relief, and the cerebrospinal fluid can, if clear and apparently normal, be carefully examined for the presence of bacteria. Sometimes a latent tubercular meningitis is fanned into fierce activity by the irritation of a simple acute otitis media.

Subdural or Extradural Abscess.—This is an inflammation of the dura mater, also called external meningitis and perimeningitis. Generally it is the result of infection from caries. Fortunately, under such circumstances the dura generally forms adhesions around the carious area of bone and thus prevents the spread of the infection. The disease then becomes a subdural abscess. The infection may remain quiescent or the dura may be penetrated, with resulting leptomeningitis or inflammation of the pia and arachnoid. Here again adhesions may prevent the spread of the infection with a resulting localized meningitis, involving also perhaps a superficial portion of the brain, or sooner or later the white matter of the brain, and the formation of one or more abscesses. The usual sites of subdural abscess following aural suppuration are the groove for the lateral sinus and the superior surface of the petrous bone. Such collections of pus can sometimes be located and evacuated by surgical intervention. Cases of spontaneous evacuation through the middle ear have been reported.

It is not very unusual during a mastoid operation to open such an abscess when removing carious bone with a curet. When the dura is thus exposed a probe should be used with great gentleness in order not to break up any adhesions that have formed between the dura and bone about the abscess cavity. At the same time the amount of bone removed should be sufficient to permit ample drainage from the infected dural surface, which is usually covered by granulations and which should not be disturbed, as they prevent the spreading infection.

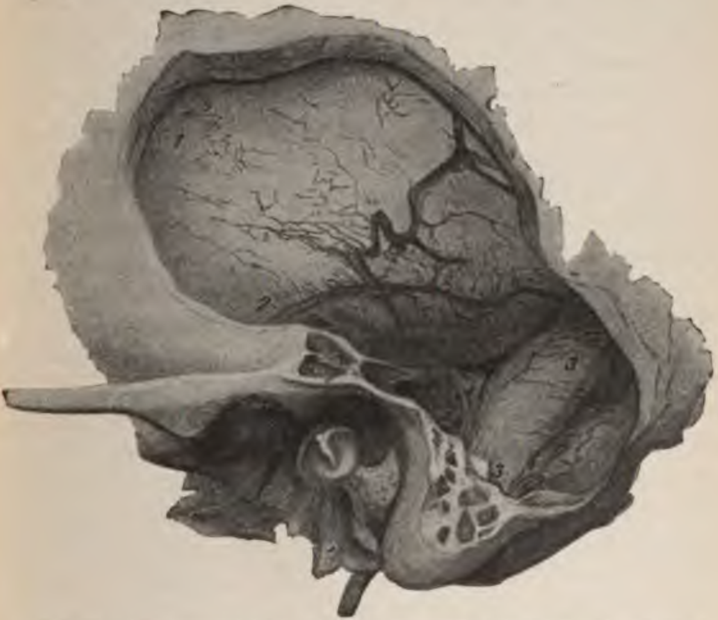

Fig. 207.—Left temporal bone, showing dura mater of cerebrum and cerebellum, the lateral sinus, the tympanic membrane, and the interior of the mastoid antrum. The anterior wall of the auditory meatus has been removed: 1, Dura mater; 2, middle meningeal artery; 3, lateral sinus; 4, mastoid emissary. (Brühl and Politzer.) See Fig. 200.

Abscesses of the cerebrum or **cerebellum** following otitis are probably invariably located on the affected side. They may be single or multiple, frequently small and connected by tiny canals. It is the white substance that is generally involved and there can be a considerable thickness of sound tissue between the abscess and the cortex. The bacteria found in the pus are various, generally those found in the discharges of the ear that has been the cause of the infection.

The disease is generally the result of chronic purulent otitis. The entire brain may be inflamed (diffuse encephalitis) or the inflammation may be localized about the abscess (localized encephalitis). A labile pupil and paralysis of the third nerve on the same side as the abscess is of diagnostic importance.

Symptoms.—Cerebral abscess may present no symptoms for many months, but at any moment acute meningitis may occur or increased intracranial pressure result in coma and death. If the abscess is acute, absorption is sufficient to produce a high polynuclear count, but if long standing and encapsulated there may be no leukocytosis and the symptoms so ill defined that the abscess is only found accidentally during a mastoid operation as the result of a telltale fistulous opening. The dura when exposed should be examined for discolorations and lack of pulsation, which, however, may not be present if the abscess is small and deep seated. When symptoms of abscess are not marked it is customary to await the result of a mastoid operation before exploring the brain. When the abscess is large, pressure symptoms appear, with possibly optic neuritis and pupillary phenomena. There is headache, slow cerebration, loss of weight, and vomiting as a late symptom.

When the left temporal lobe is involved, either by the pressure or inflammation, there may be disturbances of speech; when motor areas are affected, muscular symptoms; and when the abscess is located in the cerebellum, cerebellar ataxia with weakness of the hand grasp and rigidity of the muscles of the neck. In chronic cases there may suddenly occur a chill followed by a septic temperature, high leukocytosis, and polymorphonuclear percentage and a cerebrospinal fluid free from pus. The pulse becomes slow, there is cachexia and increasing mental dulness, ending in coma and death.

According to Macewen, if the skull be percussed 1 or 2 inches behind the junction of the frontal and parietal bones, there will be more than normal resonance if abscess is present.

The symptoms of *cerebellar abscess* are more obscure even than in cerebral abscess and the diagnosis extremely difficult. Subjects of cerebellar abscess may present absolutely no symptoms, and yet suddenly die as the result of the rupture of the abscess into the fourth ventricle.

Nystagmus is present in cerebellar abscess and suppuration of the labyrinth (p. 537). It becomes more apparent as the disease progresses in cerebellar abscess; weaker in progressive suppuration of the labyrinth.

Treatment.—Surgical intervention in all cases of intracranial suppuration is the only adequate remedy. As a general rule the cranial cavity should only be entered after removing diseased structures from the middle ear. After the antrum and attic have been cleansed the original skin wound is enlarged to a sufficient degree by an incision directly backward toward the occipital protuberance if the posterior fossa is to be explored, or directly upward from the anterior point of the mastoid wound if the middle fossa of the skull is to be opened. If the symptoms indicate the posterior fossa as the probable seat of the lesion, the groove for the lateral sinus is then opened and the sinus examined carefully for thrombus. If it is normal in appearance or covered by healthy granulations, more dura is exposed medianly by the removal of the mastoid bone from "Troutman's triangle," which is a space with its anterior angle at the prominence containing the labyrinth, bounded behind by the lateral sinus and above by the linea temporalis. At the upper posterior angle of this triangle, when the bone is removed, the superior petrosal sinus (Fig. 206) will be encountered and should be examined carefully for thrombus, which sometimes occludes this vessel without extending into the lateral sinus. While proceeding with the operation it is possible that an extradural abscess may be opened. Under such circumstances free drainage should be secured and the wound dressed. If no such collection of pus is discovered while enlarging the cranial opening, a flexible grooved director should be passed in different directions between the dura and the skull in search of pus, and finally the tegmen of the antrum and attic removed, as an extradural abscess is not infrequently located upon this thin plate or bone.

If an abscess of considerable size be present near the dura, it will bulge without pulsation into the wound. The dura should be incised for a distance of about 1 inch, and a grooved director or a brain explorer forceps with separable arms inserted carefully into the brain. Should pus escape or the instrument yield a fetid odor when withdrawn, the wound should be carefully enlarged sufficiently to allow the pus to escape and the abscess cavity gently washed out with a sterilized boric acid solution. A strip of gauze is then inserted and the wound dressed. It is probably safer to wash out the abscess cavity each day with boric acid solution. Whiting has devised an instrument which he calls an *encephaloscope*, through which the interior of the abscess cavity can be inspected, irrigated, and a drain inserted without bruising the normal brain tissue.

If no pus follow the insertion of the brain explorer into the brain, it may be inserted at another place or in another direction, with due regard for the anatomy of the parts. When searching for an abscess in the temporal lobe the explorer cannot be inserted for a distance over 4 cm. (1⅗ inches) without endangering the lateral ventricles.

While most operators find the mallet and chisel and heavy forceps like those of Keen sufficient for removal of bone for the exploration of the anterior and posterior fossa, yet a trephine can sometimes be used to advantage. One of at least ¾ inch should be employed. For epidural abscess the center pin of the trephine should be placed upon the skull 1 inch above the center of the meatus. The resulting opening in the skull, if sufficiently enlarged with the rongeur forceps, will enable the operator to explore the surface of the tegmen of the atrium and tympanum. The posterior cranial cavity may be explored by a trephine opening if the center pin of the instrument be placed 1½ inches behind the center of the meatus and ¼ inch below Reid's base line. Both the middle and the posterior cranial cavities can be explored by means of a trephine opening if the center pin of the instrument be placed 1¼ inches behind the center of the meatus and 1¼ inches above Reid's base line. As the skull in this position is comparatively thin, it is easy from such a trephine opening with the rongeur forceps to tear away the skull either downward into the posterior fossa or forward into the middle fossa.

Purulent Leptomeningitis.—In purulent meningitis the exudate becomes cloudy and mucopurulent in appearance from the presence of leukocytes. The bacteria present vary and are usually those found in the otorrhea that has caused the condition.

Pathology.—The vessels of the pia and arachnoid are infected and the membranes become cloudy. A serofibrinous or purulent exudate distends the dura or may exist only in patches. The cerebral membranes may be involved either as a whole or in part. In severe cases those of the spine are affected as well. The brain or cord may be softened in places or, as Anders states, no gross lesions, either of meninges, brain, or cord, even microscopic, are found postmortem in many cases presenting the clinical picture of meningitis.

Symptoms.—The temperature is usually from 101° to 105° F., and exhibits but slight variation during the day and night. There are severe headache, photophobia, vomiting, and localized or general convulsions. Delirium is common in young subjects, but in adults the patient is at first wakeful, but slowly passes into a condition of fatal coma. Paralysis of the pupil, strabismus, and ptosis are the most frequent forms of paralysis present.

There is often retraction and fixation of the head. Reflexes are at first increased and later diminished or absent. There is hyperesthesia of the skin. The pulse, at first full and rapid, later in the disease is slow, but becomes again rapid in the last stage. Koenig's and Babinski's signs are usually both present, and a finger drawn across the skin produces a red mark which persists for a time (*tache cérébrale*). The pupils finally become dilated. There is general paralysis and death, occurring as early as two or three days or postponed for some weeks.

Diagnosis.—True leptomeningitis differs from serous meningitis with symptoms of "meningeal irritation" or meningismus, in that it generally starts with great suddenness *a considerable time* after the onset of the aural suppuration that produced it, and may exist without symptoms of mastoiditis and runs its course with increasing rapidity of symptoms, and is somewhat rare in infants, among whom meningeal irritation and serous meningitis is far more common.

Treatment.—Where the symptoms are simply those of cerebral irritation, perfect rest in bed, large doses of the bromids, purgation with small, frequently repeated doses of calomel, and salines are sometimes sufficient to check the attack. An ice-bag should be applied to the head.

In some cases urotropin (hexamethylenamin) (Formula 92) undoubtedly does good and may be administered in 5-grain doses every two to three hours by the mouth, with colonic irrigation by the Murphy method with warm normal salt solution.

Where lumbar puncture gives relief it should be repeated daily or as often as necessary. The procedure is of value not only as a method of treatment, but as a matter of diagnosis. The amount of fluid flowing freely through the needle indicates the degree of pressure, and the microscope will disclose the presence of pus and the bacteria causing the infection. If influenza bacteria are present Woolstein's an influenzal serum may be used. Great cloudiness f pus and numerous virulent bacteria indicate an almost inevitable fatal termination by any known treatment. For this reason surgical measures, to be of value, must be instituted before general infection of the meninges has occurred. A mastoid operation should be done *before* or at least as soon as intracranial symptoms appear. This may be sufficient, especially in children, to cause a speedy subsidence of meningeal symptoms. Should this not occur, the cranial cavity should be opened in search of abscess or sinus phlebitis, and if neither are present the dura should be incised in one or more places to permit leakage of cerebrospinal fluid. Opening of the cisterna magna through a trephine opening at the base of the skull allows of continuous drainage of cerebrospinal fluid and relief of pressure symptoms. In addition, 30 to 60 gr. of urotropin a day may be given or the injection of antistreptococcus serum tried.

Sinus Thrombosis.—The lateral sinus may be infected by way of the superior petrosal sinus as the result of attic suppuration or, especially in children, the bulb of the jugular vein may be infected through the floor of the tympanum. Usually, however, the infection proceeds from the mastoid cells by the numerous small veins that reach the sinus through the bone. An early stage of the process is the occlusion of the sinus by a firm fibrinous clot which may extend backward as far as the torcular herophili or downward into the internal jugular vein. The development of septic bacteria within the clot leads to general septic infection; and if the patient survives long enough, secondary abscesses appear in various organs of the body, septic pneumonia being the most common complication; but it should not be forgotten that sinus thrombosis may produce secondary sinus thrombosis and brain abscess on the *opposite side*. Occasionally sinus phlebitis occurs as the result of the contact of necrosed bone, so that the sinus is easily torn during

vith resulting severe hemorrhage.

bitis with swelling of the sinus

walls sufficient to cause slowing of the blood current and the formation of an adherent clot which, however, never extends further than the inflammation of the vessel walls. At any part of the thickened and inflamed sinus the swelling may be so great as to completely obliterate its lumen, and if at an operation the walls of the jugular are found collapsed a clot may exist lower down toward the heart, but if the vessel walls are healthy no such clot can exist and it is useless to look for it. At the beginning the thrombus is not infected. It is only after the wall of the membranous sinus has undergone marked deterioration that the infective microorganisms penetrate it and lodge in the thrombus. That is, if the condition were diagnosticated before infection it would be prevented by the removal of the diseased bone without opening the sinus.

Symptoms.—In typic cases the temperature abruptly rises to 104° or even 106° F., and as quickly falls to normal or even subnormal. There may be only one rise in temperature during twenty-four hours, or several, depending upon the rapidity and quantity of toxin entering the system. In about 50 per cent. of cases the sudden rise in temperature is preceded by profuse sweating. The pulse corresponds with the temperature and may reach 150; but where the phlebitis is complicated by meningitis usually it is much slower. During the period of high temperature the respirations may reach 40 or 50 a minute, especially in children. Nausea and vomiting are usually present at some stage of the disease. Patients are frequently drowsy, but when aroused answer questions rationally, and usually there are no symptoms of impaired cerebration in the earlier stages of the disease.

The face is anxious, the skin is dry, and in the later stages of a yellowish hue, denoting sepsis. There is loss of appetite, a foul tongue, and fetid breath. There may be edema of the mastoid in the region of its vein and marked stiffness of the muscles of the neck, the face being drawn toward the affected side. In the later stages the inflamed jugular may sometimes be felt as a cord-like swelling at the anterior border of the sternocleidomastoid muscle. Optic neuritis occurs in less than one-third of the cases and is not followed by atrophy. Pressure over the internal jugular on the sound side produces on the sound side a temporary, artificial choked disk and dilatation of the temporal vein. Urbanschitsch states that in septic thrombosis the blood undergoes clotting twice as fast as normal blood.

Atypic cases are those following a mastoid operation when the patient does well only for a few days. The tongue becomes coated and there is a gradual rise in the temperature to 103° or even 105° F., remaining so for several days without sudden elevations and depressions. There is intense headache and inability to sleep, and if surgical measures are not adopted pyemic symptoms develop.

On inspection, the mastoid wound will be found granulating normally except at a point over the sinus, where the bone will appear darker than when exposed during the operation. If the sinus was uncovered at the operation it will be seen devoid of granulations, gray, and easily compressible.

When the bulb of the jugular vein is primarily affected from the tympanic cavity in the early stages of acute purulent otitis the symptoms are those of that disease in an aggravated form. There is, however, sudden rise in temperature to 104° F. or above, and sudden remissions to 99° or 100° F. In doubtful cases a blood-culture, showing the presence of streptococci, and a high or low leukocytosis and high polymorphonuclear percentage, renders the diagnosis more than probable. During the temperature remissions the patients, who are usually young children, feel remarkably well and ask to sit up and play with their toys, so that the uninitiated may be led to think that there is a decided improvement in the patient's condition until another rise in temperature dispels any doubt as to the n infection.

Prognosis.—A certain number of cases of bosis recover spontaneously, although it is impossible to state how many die subsequently of secondary cerebral abscess and other sequelæ of the disease. Without operation sinus phlebitis is usually fatal.

The *diagnosis* is usually easy in a typic case. When during the mastoid operation the sinus is uncovered as the result of the removal of carious bone, there is usually an epidural collection of pus. When this is removed the sinus wall may appear thicker than normal and darker in color. It may be lusterless and of a dirty white or covered with an exudate or granulations. The sinus may be flatter than normal and when pressed upon does not quickly refill as soon as the pressure is released. However, without the characteristic temperature chart these appearances are not sufficient to warrant opening the sinus.

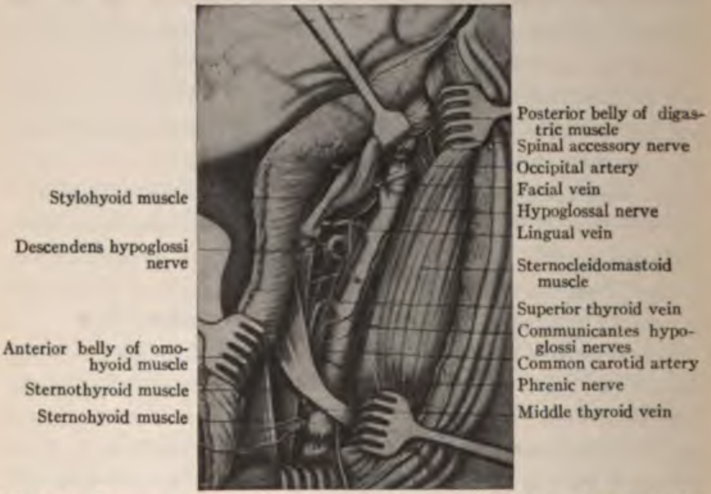

Fig. 208.—Exposure of the internal jugular vein, etc.; the vein is about ready for removal (Allport).

In 10 cases of thrombosis in the Mt. Sinai Hospital, New York, cultures of blood from the median vein were positive in 7 cases; in 5 cases Streptococcus pyogenes, 1 case Streptococcus mucosa, 1 case Bacillus proteus. A differential blood count showing a polynuclear percentage of over 80 indicates an infective process that almost certainly demands surgical intervention. The amount of leukocytosis indicates the patient's resistance to the disease.

Treatment.—Early operation if the diagnosis is certain. The only therapeutic measures of value are those which combat the asthenia. Nutritious food, 2 or 3 grains of quinin every three hours with 1 or 2 ounces of whisky, and colonic irrigation with normal salt solution by the drop method. More than ½ pint of whisky or 10 or 12 grains of quinin per day usually causes so much gastric irritation that larger doses are unadvisable.

When the mastoid antrum has been previously opened, the original opening should be enlarged backward and downward, and the sinus exposed from a point above its downward bend or "knee" to a point as near the jugular bulb as possible, but too much bone should not be removed so as to uncover a large dural area over the cerebellum, as hernias are more liable to occur at this point than in other regions of the brain. The parietal notch is over the knee of the sinus, which at this point receives the blood from the superior petrosal sinus (Figs. 207–209) at the most posterior lateral corner of the floor of the middle fossa of the skull. A line from the parietal notch to the tip of the mastoid will indicate the course of the sigmoid portion of the sinus from the knee to the jugular bulb, and a line from the notch to the occipital protuberance the course of the sinus toward the torcular herophili.

After the sinus has been uncovered a small piece of iodoform gauze should be rolled up and inserted between the sinus and the bone at the upper angle of the wound, in such a manner as to cut off the circulation in the vessel should it be present. A similar piece of gauze should also be inserted at the lower angle of the wound betw
sinus. The head of the operating tab

the wound filled with sterile water, and the sinus between the pledgets of gauze laid freely open and the contents of the vessel evacuated. If, after removing the upper piece of gauze, blood does not freely flow from the distal end of the sinus, the vessel should be further exposed toward the torcular by the removal of the overlying bone and laid open to the torcular unless a free hemorrhage is encountered before that point has been reached, as it is important that the septic clot should be removed from this region to prevent a further spread of the infection.

When the pledget of iodoform gauze is removed from the lower portion of the wound, a free hemorrhage through the sinus from the bulb is sometimes encountered. It is impossible to determine whether this comes from the internal jugular or from the inferior petrosal; but it is customary under such circumstances, if the clot removed from the sinus was firm, to desist from further operative procedures, pack the sinus with gauze, and await developments. However, if instead of a firm clot the sinus contents consist of disintegrated clot and pus, further manipulation should be suspended until the internal jugular has been ligated as low down in the neck as possible. The line of the internal jugular vein is from the tip of the mastoid to the intraclavicular notch. The patient is placed in the tracheotomy position with a sand-pillow under the shoulders and the face turned toward the opposite side. An incision is made along the anterior border of the sternocleidomastoid muscle and the vein exposed by dry dissection. The wound should not be held open as in Fig. 208, because this procedure interferes greatly with easily finding the vein, which lies immediately beneath the anterior border of the muscle to the outer side of the carotid with the pneumogastric nerve behind both vessels. A double ligature is applied to the vein as low down as possible and the vein severed between the ligatures. The vein should then be resected upward to its exit from the *skull.* All diseased lymphatics encountered during this

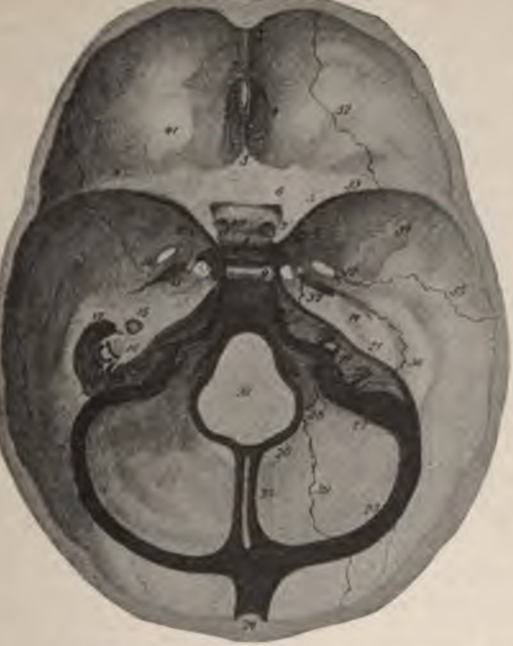

Fig. 209.—Base of skull; left labyrinth exposed on the right side; the grooves in the base of the skull are shown; the sinuses of the dura mater are marked in black (two-thirds life size): 1, Crista frontalis (on the left, beginning of the superior longitudinal sinus); 2, foramen cecum (emissarium santorini); 3, crista galli; 4, lamina cribrosa (olfactory nerve); 5, lesser wing of sphenoid; 6, optic foramen (optic nerve, ophthalmic artery); 7, anterior clinoid process; 8, sella turcica, flanked by the median clinoid process; 9, dorsum ephippii, with posterior clinoid process; 10, foramen rotundum (second division of fifth nerve); 11, foramen ovale (third division of fifth nerve); 12, foramen spinosum (middle meningeal artery and recurrent branch of fifth nerve); 13, carotid canal and foramen lacerum anterius (great and lesser superficial petrosal nerves, eustachian tube, and tensor tympani muscles); 14, anterosuperior surface of pyramid; 15, cochlea; 16, semicircular canals; 17, tegmen tympani and roof of antrum laid open; 18, anterior condyloid foramen (twelfth nerve); 19, posterior condyloid foramen (emissarium santorini); 20, foramen magnum; 21, superior petrosal sinus; 22, transverse sinus (descending portión); 23, transverse sinus (horizontal portion); 24, superior longitudinal sinus and torcular herophili (confluence of the sinuses); 25, occipital sinus; 26, occipital sinus; 27, vein of aquæductus vestibuli (emerging at the external aperture of aquæductus vestibuli); 28, internal auditory vein (emerging in the internal auditory meatus); 29, vein of aquæductus cochleæ (emerging at the external aperture of aquæductus cochleæ); 30, inferior petrosal sinus emptying into the cavernous sinus; 31, circular sinus (Ridley); 32, groove traversing anterior fossa of skull; 33, sinus of lesser wing of sphenoid; 34, groove for meningeal artery; 35, transverse groove through middle fossa of the skull; 36, longitudinal groove through petrous portion of temporal bone (tegmen tympani); 37, groove through apex of pyramid; 38, transverse fissure (between posterior condyloid foramen and foramen magnum); 39, longitudinal groove through posterior fossa of skull; 40, impressio carotica (corresponding to the bend in the internal carotid artery); 41, juga cerebralia and impressiones digitatæ (Brühl and Politzer).

procedure should be removed, and tributary branches ligated as far away from the vein as possible. These consist of the middle and superior thyroid, the lingual and facial veins, and all enter the jugular at its median border. After this has been done the contents of the sinus above should be evacuated. Under these circumstances there will be a free hemorrhage through the bulb from the inferior petrosal sinus. Should this not occur, as fortunately is rarely the case, it indicates that the inferior petrosal sinus is obstructed, and should the patient's condition permit, this sinus and the superior, if necessary, should be exposed and emptied of their contents. The wound in the neck may be treated by the open method, the skin subsequently being drawn together by adhesive strips, or a cigarette drain may be inserted and the skin sutured.

Facial paralysis, or Bell's palsy, is a paralysis or paresis of some or all of the muscles supplied by the facial nerve. In the graver form of the disease there is complete immobility of the muscles of expression of the affected side of the face, slight deafness from involvement of the stapedius muscle, unilateral paralysis of the uvula and the palate, and unilateral impairment of the sense of taste at the anterior two-thirds of the tongue, through involvement of the chorda tympani nerve.

Etiology.—The disease may be *central,* as the result of basilar meningitis, tumors or exostoses at the base of the brain, syphilitic lesions in this situation, or aneurysm of the vessels at the base of the brain. Not a few cases are apparently rheumatic and result from exposing one side of the face to a draft, sitting in a damp room, or suddenly chilling the body when overheated. This disease is of interest to the aurist chiefly from the fact that it may occur as a complication in a large variety of middle-ear affections, or as a result of the nerve being bruised or wounded during the course of an operation upon the middle ear, or from packing the wound too tightly after the operation. It should be borne in mind that the facial canal arches backward over the oval window and then descends almost perpendicularly through the temporal bone. As the result of the oblique position of the drum-head the facial canal approaches in some skulls to within 1 millimeter of the annulus, at a position about midway between the floor and the roof of the canal. The pressure of a polypus or an accumulation of epithelium or cerumen on the nerve through the thin bone of this region is sufficient in some cases to produce paralysis of the facial nerve, usually remediable by the removal of the offending body. Generally, however, the facial nerve in its passage through the middle ear is defended by comparatively thick and hard bone. In some instances, however, the bone covering the nerve above the oval window is as thin as tissue-paper, and congenital dehiscence of the bone of this region is by no means uncommon, so that the nerve in such cases lies almost immediately under the mucous membrane. Such a congenital lack of bone in this position explains the occasional occurrence of facial paralysis as the result of simple non-suppurative catarrh of the middle ear. Suppuration of the middle ear is a common cause of facial paralysis, sometimes so slight that the lack of mobility of the affected side of the face can be detected only by the closest scrutiny; at other times the paralysis is complete and involves all the muscles supplied by the facial nerve on the affected side of the face. Such cases are doubtless the result of pressure on the nerve caused by spreading of the inflammation from the mucous membrane to the bony wall of the facial canal and the sheath of the nerve, and are the more favorable instances of the disease; for after the subsidence of the inflammation and the absorption of the exudation the facial paralysis disappears spontaneously. Facial paralysis occurs during caries and necrosis of the temporal bone if the inflammation and destruction extend to the nerve; but caries of the facial canal is not always accompanied by paralysis, for the nerve has been exposed and bathed in pus for months without the occurrence of facial paralysis. Facial paralysis in more than one instance has followed the simple removal of the drum-head and larger ossicles, and is not uncommon as the result of the mastoid operation. Most of these cases ultimately completely recover, sometimes even when there was reason to suppose that the nerve had been completely severed. When working in the neighborhood of the facial nerve some operators direct their assistant to watch for slight twitching of the muscles of the face, and desist immediately should this occur.

Symptoms.—Double facial paralysis is somewhat rare. When it does occur and is complete, the face is absolutely expressionless and as immobile as that of a graven image. Facial paralysis sometimes appears quite suddenly, but in many instances there are premonitory symptoms of pain in the side of the head and twitching of the muscles of the side of the face. A patient suffering from complete facial paralysis is unable to wrinkle the brow or close the eyes, although the upper eyelid often descends somewhat during the effort. On account of the paralysis of the orbicularis the punctum lacrimalia drop away from the globe and the eye is constantly suffused with tears, and, being no longer protected from dust and cold by the motionless lips, soon becomes inflamed. The ala nasi on the affected side cannot be distended during inspiration, and hence nasal respiration and the sense of smell are impaired on the affected side. The angle of the mouth drops a little and is drawn somewhat toward the unaffected side. While drinking, some of the fluid dribbles from the corner of the mouth, and the food collects between the cheek and the teeth, so that it is necessary while eating to remove it from time to time with the finger. If the cheeks are distended, air escapes at the corner of the mouth, and because of the paralysis of the palate muscles it is usually necessary to employ the eustachian catheter if the ears require inflation. The hearing is usually somewhat impaired as the result of paralysis of the stapedius muscle, but sometimes becomes still worse, if care is not exercised, from eustachian salpingitis resulting from the paralysis of the tubopalatine muscles. When an attempt is made to smile the entire lower part of the patient's face seems to move toward the unaffected side. If recovery does not occur the affected muscles sometimes undergo atrophy, so that the affected side of the face looks smaller than the other. Contractures and spasms of the affected muscles in some cases finally occur, the spasms being clonic in character and not painful. As the result of contracture the angle of the mouth is sometimes drawn upward and the nasolabial fold deepened until at the first glance it would appear as if the unaffected side of the face were the paralyzed one.

In many instances the paralysis of the facial muscles is not complete, the muscles of the lower portion of the face being the ones most affected. However, the muscles of the lower portion of the face and those of the forehead as well may be almost completely paralyzed, while the eye can still be completely shut, although with considerable effort. As this form of paralysis is the most common after middle-ear operations, it would appear that the fibers of the nerve supplying the muscles of the lower part of the face and the forehead occupied a more superficial position within the facial canal than those supplied to the orbicularis palpebrarum.

Diagnosis.—In the variety of the disease due to a central lesion the paralysis usually occurs after an apoplectic seizure, and other muscles are generally affected besides those of the face. Generally in such cases the muscles of the forehead and the orbicularis palpebrarum are affected to a considerable less degree than those of the other parts of the face, and the electric contractility of the affected muscles is not affected in the slightest degree, no matter how profound the paralysis may be. In a certain proportion of cases the unilateral paralysis of the palate, impairment of the function of taste at the anterior two-thirds of the tongue, and the presence of a disease of the middle ear that is capable of causing a lesion of the seventh nerve are points that will help to clear up the diagnosis. In peripheral facial paralysis it is sometimes possible to determine with a certain amount of accuracy the portion of the seventh nerve in which the lesion has occurred. If the lesion is above the geniculate ganglion there will be paralysis of all the facial muscles and those of the palate and uvula, with disturbance of hearing, but the sense of taste will be unimpaired because the chorda tympani nerve enters the facial at the geniculate ganglion. If the lesion is between the geniculate ganglion and the point at which the nerve to the stapedius muscle is given off there will be paralysis of the facial muscles, disturbance of hearing, and impairment of the sense of taste, but the movements of the soft palate will remain unimpaired because its motor fibers are supplied from the geniculate ganglion. If the lesion is situated between the point where the stapedius nerve is given off and the point where the chorda tympani leaves the nerve, the former symptoms will be present, with the exception that there will be no disturbance of hearing; and if the lesion is below the point where the chorda leaves the facial nerve there will simply be paralysis of the muscles of one side of the face. In order that the above should be practical for purposes of diagnosis it is necessary that the lesion should be sufficiently great to involve all the fibers of the nerve, which, of course, is not always the case.

The *prognosis* depends upon the nature of the lesion producing the facial paralysis. When a portion of the nerve has sloughed away as the result of caries of the temporal bone recovery from facial paralysis is not to be expected, and where the nerve has been completely divided during a middle-ear operation complete recovery rarely occurs. Cases of paresis of the facial nerve and cases where only a part of the muscles of the face are involved usually result in complete recovery. The development of contractures and spasms is a most unfortunate event, as no cases where this occurs recover from the facial paralysis; and considerable deformity of the face is usually the result of the contractures and spasms. When the electric excitability of the nerve and muscles remains unchanged spontaneous recovery in from three to eight weeks may be expected, providing the middle-ear disease that produced the lesion of the nerve ceases to be an active factor in the case. In many cases the excitability of the nerve and muscles to the faradic and galvanic currents begins to diminish within a few days of the onset of the paralysis, and is entirely lost at the end of a week or ten days; and this extinction of electric excitability continues until the patient begins to recover. Usually, in such cases, the patient is able to produce voluntary movements of the paralyzed muscles before the nerve begins to react to electric stimuli. The case should not be regarded as hopeless when electric excitability of the affected muscles is entirely lost for a short period; but such cases recover slowly, from six to nine months usually elapsing before a cure of the paralysis occurs.

Treatment.—If diseased, the middle ear should, of course, receive appropriate local treatment. In rheumatic cases and those resulting from disease of the middle ear it is well to place the patient upon full doses of iodid of potassium, and an ointment composed of equal parts of mercurial, iodin, and belladonna ointments should be rubbed into the skin over the mastoid and below the ear sufficiently often to keep the parts slightly sore to the touch. After from one to three weeks have elapsed and reaction has set in, it is well to begin the use of electricity, preferably the faradic current, to the affected muscles, but in some cases better results are obtained from the employment of the galvanic current. A weak galvanic current may be sent along the affected nerve-trunk by placing a medium-sized electrode over each ear (the negative on the affected side), and passing a current between them. The faradic current may be applied to the affected muscles by placing a small electrode over them in turn; or the electrode may be passed along a line in front of the auricle in order to reach the fibers of the pes anserinus where they cross the side of the face. The current should be of sufficient strength to produce contractions of the affected muscles, and the sittings should last not longer than ten minutes every day or every other day. During an operation if the nerve is cut, the ends should be approximated in the hope that they will unite. If it is impossible to suture, some fine fibers of catgut should be passed alongside the nerve and the part protected from the dressing by a strip of rubber tissue.

In cases where a considerable section of the facial nerve has been removed during a mastoid operation and in some other cases successful neuroplastic operations have been reported.

The facial nerve is located at the posterior border of the parotid gland and dissected back to the stylomastoid foramen, where it is cut off as high up as possible. The cut end of the nerve is then implanted into the trunk of the spinal accessory, glossopharyngeal, or, preferably, the hypoglossal.

DISEASES OF THE PERCEPTIVE APPARATUS

Diagnosis Between Middle-ear Deafness and that Resulting from Disease of the Internal Ear.—The diagnosis is made from the history of the case and by means of tuning-forks.

It must not be supposed that tests with the tuning-fork are infallible, for example, in cases in which the capsular ligament around the stapediovestibular joint has become stiff as the result of disease, it is easy to understand how the stapes can become fixed in the oval window as the result of a blow on the side of the head or the concussion produced by the unexpected discharge of firearms. Under such circumstances suspension of the function of hearing will result from increased intralabyrinthine pressure. The symptoms under such circumstances would all point toward disease of the labyrinth, and yet the hearing may become nearly normal as the result of vigorous inflation of the middle ear by Politzer's method. It is evident that in a case of this kind there was no actual disease of the labyrinth.

Anemia of the labyrinth may be part of a general anemia or due to some local cause affecting the blood-supply, such as tumors of the brain, endocarditis, osteosclerosis, or embolism of the auditory artery.

Symptoms.—After profuse hemorrhage from any cause there is tinnitus, vertigo, and nausea as the result of anemia of the labyrinth. These symptoms are made worse by sitting or standing and are ameliorated by lying down. The same is true of anemia of the labyrinth from other causes than hemorrhage. In anemia of the labyrinth the acuteness of hearing is impaired both for aërial and bone conduction.

Hyperemia of the labyrinth may result from most of the acute infectious diseases, middle-ear inflammation, some intracranial diseases, valvular disease of the heart, the menopause, plethora, gout, alcoholism, quinin, amyl nitrite, salicylic acid compounds, calcium chlorid, the irritation resulting from long use of the telephone receiver, loud noises, vasomotor disturbances, etc.

The *symptoms* are similar to those of anemia except that *they are intensified by the horizontal position.* The auricle, auditory canal, and drum-head may visibly participate in the hyperemia. Occasionally individuals are encountered in whom a few grains of quinin or salicylate of sodium will produce visible hyperemia of the auricle, canal, and drum-head; also tinnitus, presumably from hyperemia of the labyrinth.

The *treatment* is systemic. The symptoms are made worse by inflation and massage. Relief of tinnitus may be obtained from hydrobromic acid or the bromic
paratively large doses (20 to 30 gr. three t
required.

Significance of a Discharge of Blood from the Internal Ear.—Occurring after traumatism a discharge of blood from the internal ear through the tympanum and external auditory canal may indicate fracture of the base of the skull. Cerebrospinal fluid may escape from the ear either as the result of fracture of the base of the skull or injury of the structures of the oval or round windows or the aquæductus fallopii.

Concussion of the Labyrinth.—The *symptoms* are sudden deafness following concussion or a blow, without visible local injury. Tinnitus is usually present. The prognosis is unfavorable, but $\frac{1}{16}$ to $\frac{1}{8}$ gr. of pilocarpin should be injected subcutaneously each day until symptoms of weakness of the patient occur or it is manifest that the treatment is unavailing.

Hysteric deafness is a somewhat rare symptom occurring in hysteric women. The deafness may be complete, lasting for several hours or days. Treatment is the same as for other hysteric conditions.

Syphilis of the Internal Ear.—Plastic exudations may occur within the labyrinth similar to those occurring in plastic iritis. The disease is ushered in by loud subjective noises, deafness soon following. There is usually a noticeable disturbance of the patient's gait and he complains of constant dizziness. The prognosis is not altogether unfavorable if vigorous antisyphilitic treatment is begun early. In congenital cases ear symptoms usually occur between the ages of ten and fourteen years; in many instances following interstitial keratitis. A course of pilocarpin sometimes quickly, but often only transiently, benefits such cases and should not be allowed to interfere with antisyphilitic treatment. However, salvarsan should be used with caution, as it is sometimes followed by Ménièreform polyneuritis appearing some weeks after an injection at a time when the Wassermann reaction has become negative and there is *every reason* to attribute the disaster to the remedy.

According to Bernaris, of 14,000 cases treated by salvarsan some intracranial nerve lesion occurred in 1 of every 111, and auditory nerve lesion in 1 of every 226 cases. Ehrlich explains the occurrence by the theory that spirochetes are protected by the dense fibrous tissue of the nerve sheath and some months after the injection become active. He attributes the disasters to badly prepared or insufficient doses of salvarsan. Alexander, however, attributes the labyrinthitis to arsenic, and states that salvarsan is a dangerous remedy in the acute stages of all labyrinthine disease and in acute exacerbations of chronic disease; whereas it is a safe remedy in chronic disease of the labyrinth and auditory nerve.

Metastasis may occur in parotitis or mumps to the labyrinth, with an exudation of a plastic material, the symptoms being deafness, tinnitus, and vertigo. If the affection is treated early, before the organization of the plastic material, with hypodermic injections of pilocarpin the prognosis is not altogether unfavorable.

"Ménière's disease" is a name given to a group of symptoms which may be caused by various affections of the labyrinth, the acoustic nerve, or the central nervous system, usually apoplectiform in character. There are sudden loss of hearing, tinnitus, and vertigo often to such a degree that the patient is unable to maintain his balance and falls to the ground (see p. 419).

Hemorrhage into the labyrinth may occur as the result of degeneration of the blood-vessels, traumatism, hyperemia, concussion from explosions, etc.

The *symptoms* are sudden deafness, nausea, syncope, vertigo, with a tendency to fall toward the affected side, and pathologic nystagmus, spontaneous or induced, by the turning, caloric or galvanic tests, by which it is possible often to differentiate at least approximately the portion of labyrinth involved.

Prognosis.—If the hemorrhage is small it may be completely absorbed, with a restoration of the normal functions of the ear, but should the extravasation undergo fibrous degeneration the partial deafness will be permanent. Tinnitus, vertigo, and nausea, however, will disappear. Should the clot become infected, the infection may extend to the cranial contents.

Treatment consists in free catharsis and absolute rest in bed. Pilocarpin hydrochlorate may be given in $\frac{1}{10}$-gr. doses once or even twice a day with the usual precautions for five or six days or longer if it produces a decided improvement in the aural symptoms. Iodid of potassium should be given in conjunction with or after the use of pilocarpin, in 10- or 15-gr. doses three times a day, or, if there is a history of syphilis, the dose should be further increased. After the lapse of some months quinin may be given slightly above the tonic dose to increase the supply of blood to the labyrinth and promote absorption if deafness and tinnitus still persist.

Diseases of the Static Labyrinth or Vestibular Apparatus.--The faculty of equilibrium depends upon three sets of sensations, derived respectively from the eyes, labyrinths, and muscles. If one set of functions is completely destroyed, vertigo does not result because the remaining two are sufficient to maintain equilibrium. Hence the destruction of both vestibules with their semicircular canals does not cause dizziness because sight and muscular sense are still sufficient to maintain equilibrium; but if, in addition to paralysis of the labyrinths, either sight or muscular sensations are destroyed, vertigo results.

Infants gradually learn to maintain equilibrium by the correlation of these three sets of sensations; but if a child is born with a labyrinthine lesion he becomes accustomed to the false impressions derived through it and has no vertigo. If an adult, accustomed all his life to normal sensations from his organs of equilibrium, acquires a labyrinthine disease, he will be subjected to conflicting sensations with resulting *vertigo,* which persists until he becomes accustomed to these conflicting sensations. If the labyrinthine disease is progressive he may never become accustomed to the resulting conflicting sensations, and hence never entirely recover from his vertigo.

For example, in Ménière's disease, when the entire vestibular apparatus of one ear is paralyzed or destroyed as the result of hemorrhage, the consequent vertigo remains until the patient becomes accustomed to the loss of sensations from the destroyed vestibule. In cases where there is a succession of small hemorrhages the patient must become accustomed to sensations varying with each new lesion, and consequently has recurrent vertigo. Even when free from vertigo such patients should be cautioned about ascending ladders or going on scaffolding, etc.; but when there is complete destruction of the semicircular canals after recovery from the transient vertigo it has caused, this precaution is not necessary. Spontaneous falling is generally toward the side of the lesion; therefore if the direction of the falling changes with the position of the head, the lesion is within the labyrinth.

Ewald's Law.—Ewald, as the result of experiments upon the semicircular canals of pigeons, demonstrated that *nystagmus resulting from endolymph currents in a semicircular canal is in a direction parallel with the plane of that canal and opposite to the current, and that in the horizontal canals the amount of ocular motor impulse derived from the canals whose hair cells are bent toward the utricle is twice as great as from the other; but in the vertical canals the reverse is true.*

Vestibular nystagmus may be horizontal, vertical, oblique, or rotary. It results from stimulation of the vestibular apparatus and cortical nuclei. The former produces a slow movement and the latter a quick one. Because the quick movement is more readily observed it is the one generally referred to as "nystagmus." Hence, "horizontal nystagmus to the right" means the quick movement of the eyes to the right. However, this quick movement ordinarily disappears under general anesthesia, while the slow movement does not; also in certain lesions of the cerebral cortex stimulation of the labyrinth does not produce nystagmus, but only conjugate deviation of the eyes.

Nystagmus of vestibular origin is always rhythmic. It consists of (1) a quick movement of the eyes (cortex) and a slow return movement in the opposite direction (vestibule). (2) It increases in length of excursions and rapidity when the eyes are turned voluntarily toward the direction of the quick movement, and (3) it weakens or disappears when the eyes are turned in the direction of the slow movement.

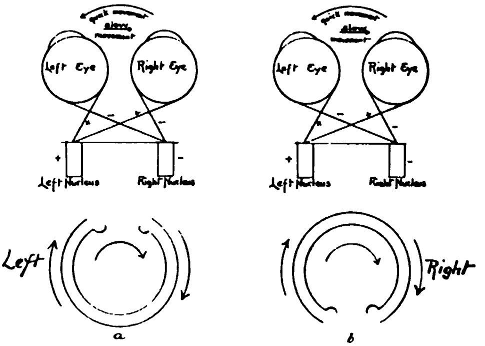

Fig. 210.—Semicircle resulting from joining the indifferent ends of (*a*) horizontal and (*b*) vertical semicircular canals, brought into the horizontal plane by bending the head forward at an angle of 120 degrees. The arrows represent the endolymph current at the end of the turning to the right; the + and — signs, the direction of the consequent motor impulses. In the horizontal canals the motor impulse derived from the ampulla whose hair-cells are *bent toward* the utricle is about twice as strong as that derived from the other ampulla. In the vertical canals the motor impulse is twice as great from the ampulla whose hair-cells are *bent away* from the utricle.

Nystagmus from eye lesions is oscillatory like the movements of a pendulum and cerebellar nystagmus gets worse as the disease progresses; vestibular nystagmus decreases with time, whether the vestibular disease gets well or progresses to complete destruction of the labyrinth.

Spontaneous vestibular nystagmus may be apparent even when the eyes are directed forward, or only seen when the eyes are turned in the direction of the nystagmus. Spontaneous vertical nystagmus even with the eyes turned upward or downward indicates an intracranial lesion; but spontaneous lateral nystagmus may result either from disease of the labyrinth or intracranial structures. In some cases of vestibular disease nystagmus only occurs as the result of the application of turning, caloric, or galvanic tests, which also develop nystagmus in normal individuals.

For purposes of study the semicircular canals can be divided into an ampulla end, containing the sensitive hair-cells, and an indifferent end. If, for example, the indifferent ends of the horizontal semicircular canals should be joined together, a semicircle would result with an ampulla at each end, and these ampullæ, according to Ewald's law, work together, increasing nystagmus. If the arrows (Fig. 210, *a*, lower figure) represent the direction of the endolymph current, the resulting nystagmus (quick movement, upper figure) is in the opposite direction as the result of impulses derived from each ampulla. However, in the horizontal canals the stimulation derived from the ampulla whose hair-cells are bent toward the utricle is twice that of the other ampulla. With the rotating chair (Fig. 211) it is possible to demonstrate destruction of the vestibular apparatus such as occurs in epidemic cerebrospinal meningitis. In these cases neither vertigo nor nystagmus can be produced by turning, and such persons do not experience seasickness. Their sense of equilibrium is derived from sight and the muscle sense alone, which is adequate under ordinary circumstances, but if such an individual were guiding an aëroplane and the sight of the earth were cut off by a cloud, he would be unable to maintain the equilibrium of his machine. A simple test always available for demonstrating in a rough way whether the horizontal canals are functionating or not, is for an individual with eyes shut and head bent slightly forward to walk rapidly five or six times around a cane held close to the body in the right hand if the individual walks to the right, and in the left if the individual walks to the left. He then opens his eyes and tries to walk forward in a straight line. Individuals with normal horizontal semicircular canals are unable to do this, but stagger and may fall in the direction in which they have been turning, while those with sufficiently impaired horizontal canals are able to walk quite straight.

Functional Tests.—*Turning.*

To produce nystagmus by turning, the semicircular canal to be tested must be in the same plane as the turning. For the horizontal, this is brought about by bending the head downward at an angle of about 30 degrees; or so that the outer canthus and the external auditory meatus are in the same horizontal plane. To examine the condition of the horizontal semicircular canals the patient is seated with his eyes shut in a chair that is revolved ten times in twenty seconds. Because of the inertia of the endolymph, at the beginning of the turning, if it be to the right, the cilia in the right ampulla are bent toward the utricle and away in the left ampulla; but at the end of the turning, because of this same inertia, the current of endolymph continues to flow in the direction of the turning, and, according to Ewald's law, there will be horizontal nystagmus toward the left (Fig. 210). In normal individuals after-turning nystagmus lasts about twenty-four seconds if the eyes look straight ahead, of which sixteen seconds are from stimulation of the left labyrinth and only eight seconds from the right when the turning is to the right. The length of time after-turning nystagmus lasts is increased if one or both labyrinths are inflamed. If one labyrinth is destroyed, the after-turning nystagmus will result only from impulses from the remaining normal labyrinth. Its duration will be diminished to a different extent according as the turning is to the right or left. For example, if the left labyrinth is destroyed, after-turning nystagmus to the right is reduced to $24'' - 16'' = 8''$—this eight seconds of nystagmus representing the reaction from the right or well ear. After-turning nystagmus to the left, on the other hand, is $24'' - 8'' = 16''$.

This sixteen seconds of nystagmus also representing the reaction from the right or well ear; because, as already stated, the stimulation from an ampulla whose hair-cells are bent toward the utricle is twice as great as when the cells are bent in the opposite direction.

Examination of the condition of the vertical canals by turning is rendered possible by inclining the head downward at an angle of 120 degrees. The position of the vertical canals is then approximately horizontal. The chair in which the patient is seated is turned in the same manner as in the examination of the horizontal canals (Fig. 210, *b*). The resulting after-nystagmus is observed when the patient opens his eyes, elevates his head, and gazes straight before him into vacancy. It is of slightly shorter duration normally than that produced from the horizontal canals and is rotary instead of horizontal.

If the nystagmus resulting from turning to the right equals in duration and amplitude that from turning to the left, it indicates that the vertical semicircular canals of both ears are functionating to the same degree. If the amplitude and duration of the nystagmus is decreased, it indicates that the vertical canals of both ears are functionating poorly, or that there is a lesion of the nerve-fibers either from the labyrinth to the intracranial nerve-centers, or that these centers themselves are impaired. Increased amplitude and duration of the nystagmus indicate labyrinths that are more irritable than normal, generally as the result of commencing inflammation. Normally, after turning, nystagmus from the vertical canals is of about twenty-one seconds' duration; of which two-thirds is from the ampulla whose hair-cells are bent away from the utricle, and one-third from the ampulla whose hair-cells are bent toward it (Fig. 210, *b*).

For example, if the left vertical canal is not functionating and the patient is turned to the right with his head bent forward at an angle of 120 degrees, the resulting nystagmus should be of about seven seconds' duration from stimulation of the right or normal ear, and of about fourteen seconds' duration by turning to the left, and thus also stimulating the right or normal ear, but to a greater degree because the resulting current in the vertical canal is then away from the utricle (Fig. 210, *b*).

The vertical canals also are made horizontal by tilting the head backward at an angle of 60 degrees; but instead of the ampullæ pointing posteriorly, as in Fig. 210, *b*, they then point forward, as in Fig. 210, *a*. Hence the effect of examining the vertical canals with the head tilted backward is precisely the same by turning to the right as is obtained by turning to the left with the head bent forward. However, bending the head backward is a more convenient position for applying the caloric test to the horizontal canals.

Caloric tests, the significance and technic of which were established by Báráany of Vienna, depend upon the fact that if a normal ear is irrigated with cold water there is produced rotary nystagmus toward the other ear. There is also produced vertigo and marked ataxia and sometimes nausea and vomiting. The vomiting is probably due to irritation of the root of the vagus in the floor of the fourth ventricle. If hot water is used, there is nystagmus toward the irrigated ear. In either instance nystagmus is increased by the patient's looking in the direction of the nystagmus. If the vestibular nerves are irritated, for example, by a small circumscribed abscess, there will be spontaneous nystagmus toward the affected side and syringing will produce a positive reaction. If the nerve-endings are rapidly destroyed, as, for example, by diffuse suppuration, there will be spontaneous nystagmus for a few days or weeks toward the sound side, its origin being the sound ear, and syringing the diseased ear will yield no response. When a case is of sufficiently long standing for the nystagmus to the diseased side to have disappeared and there is no response to functional tests by the dead labyrinth, there is danger of the suppuration extending to the intracranial contents, especially if an operation is undertaken that does not include exenteration of the labyrinth, or at least establishing ample drainage from the pus cavity within the labyrinth.

When the caloric test is made simply to demonstrate whether or not the static labyrinth has ceased to functionate, cold water is usually preferred, because the tissues tolerate more readily water 30 or even 40 degrees below that of the body than water even 20 degrees above. After syringing an ear for five minutes with water whose temperature is 68° F., without producing either nystagmus, vertigo, or past pointing, it may be assumed that the static labyrinth does not functionate unless the middle ear is protected from the impact of the cold water by chloesteatoma or polypi.

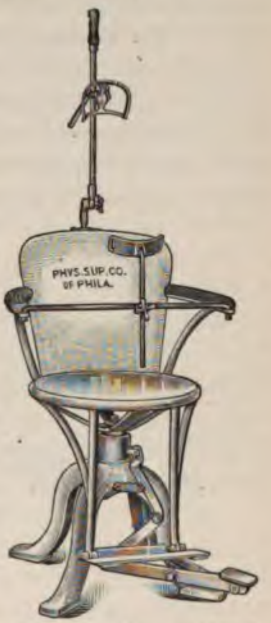
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Fig. 211. — Improved Bárány chair. The chair with which Bárány did most of his work was of the simplest construction, practically an ordinary revolving office chair. Hence an elaborate chair is not absolutely necessary, but adds very much to the convenience and accuracy with which turning tests are made, especially when the services of one or more assistants are not available.

Caloric tests have the advantage over the turning tests from the fact that each ear is examined separately. However, the nystagmus, ataxia, and vertigo which it produces is long continued and distressing and even increases for a time after the syringing has ceased. Therefore it is usually advisable after syringing with cold water to limit the duration of the resulting nystagmus and vertigo by syringing with hot water so as not to unnecessarily prolong the patient's distress.

For the caloric test an ordinary irrigator such as is used for surgical purposes is generally employed. It is elevated about 2 feet above the patient's head. If it is desired to make a quantitative test of the excitability of the labyrinth, the temperature of the water used should be exactly 68° F. The patient is seated in the chair used for turning tests (Fig. 211), with his head inclined forward at an angle of 30 degrees. The auditory canal is straightened by drawing the auricle upward and outward and the stream of cold water directed against the drum-head if it be present, or into the tympanum if it be absent. The patient is instructed to look downward, and one of his upper eyelids is elevated with the observer's finger to better observe the nystagmus. The time between the commencement of the irrigation and the beginning of the nystagmus is carefully noted with a stop-watch. If the vestibular apparatus is very irritable, and there is no obstruction in its efferent and afferent nerve tracts, nystagmus and vertigo occur within a few seconds. On the other hand, if the vestibular apparatus is inactive or its efferent or afferent nerve tracts obstructed by a gumma, for example, in the cerebellopontine angle, the nystag-

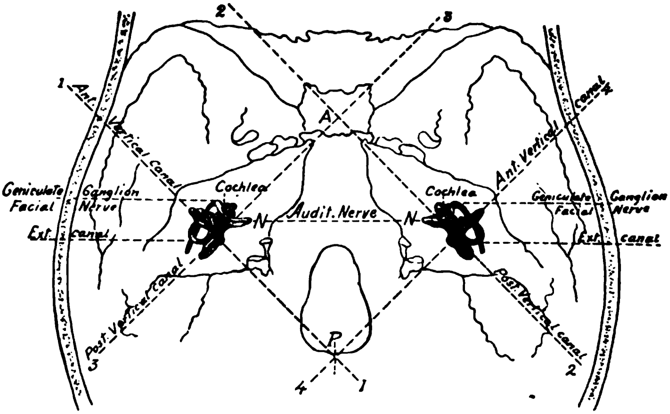

Fig. 212.—Semischematic representation of two labyrinths showing relative positions of semicircular canals to each other (modified after Mackenzie).

mus will be feeble and many seconds will elapse before it appears at all, and perhaps there will be little or no vertigo. The average time for the appearance of nystagmus when the vestibular apparatus is intact is about forty seconds. If after irrigating the ear for five minutes no nystagmus appears, it probably will not appear at all.

When a portion of the endolymph is cooled by syringing cold water into the ear, its specific gravity is increased and it sinks by its own weight through the labyrinth and a current is thus produced. With the head erect, this current will be downward toward the ampulla in the superior vertical canal; but because of their common duct probably also a secondary current will be produced in the posterior vertical canal which will be away from the ampulla. The resulting nystagmus is rotary and in a direction toward the syringed ear when it is syringed with hot water, and away from the syringed ear when syringed with cold water. The fact that cold irrigations cause nystagmus toward the opposite ear and warm toward the irrigated ear is sometimes memorized by students with the assistance of the word "cows": *c* (cold), *o* (opposite), *w* (warm), *s* (same).

The horizontal canals can be made vertical by tilting the head backward as nearly to 60 degrees as possible. It can be supported in this position either by the hands of an assistant or by a rest attached to the chair. If while the head is in this position one ear is syringed with cold water, a current will be produced in the horizontal canals with a resulting horizontal nystagmus in a direction away from the syringed ear. This nystagmus disappears as soon as the head is brought into the erect position. When after syringing the ear with cold water with the head bent forward at an angle of 30 degrees, the characteristic rotary nystagmus is established, if the head is tipped backward at an angle of 60 degrees so as to render the horizontal canals vertical, a current is produced in them with a resulting horizontal nystagmus toward the opposite ear just the same as would be produced if the ear were syringed with cold water when the head was in this position.

According to Randall and Jones: "1. The fibers from the horizontal semicircular canal pass through the eighth nerve, enter the brain stem at the junction of the medulla oblongata and pons, and continue directly to Deiters' nucleus and there divide into two pathways: (*a*) The vestibulo-ocular tract, concerned in the production of the nystagmus. These fibers go from Deiters' nucleus to the posterior longitudinal bundle through which they pass to the various eye-muscle nuclei, from which, through the third, fourth, and sixth nerves, they are distributed to the eye muscles themselves. (*b*) The vestibulo-cerebello-cerebral tract, responsible for the vertigo. From Deiters' nucleus this path enters the cerebellum through the inferior cerebellar peduncle to the three vestibular cerebellar nuclei of the same side, from which it proceeds upward through the superior cerebellar peduncle and continues to the cerebral cortex on both sides, but more particularly the opposite side, through the crura cerebri and the internal capsules. The cortical areas which receive these fibers are postulated by Mills to be in the posterior portion of the second temporal convolutions adjacent to the cortical area for hearing.

"2. The fibers from the vertical semicircular canals have a very different course; after passing through the eighth nerve they immediately ascend into the pons and at a point above the middle of the pons they have a division into two pathways similar to the division of the horizontal canal fibers at Deiters' nucleus: (*a*) The vestibulo-ocular tract, the fibers entering the posterior longitudinal bundle. (*b*) The vestibulo-cerebellar-cerebral tract reaches the cerebellum through the middle cerebellar peduncle, entering the cerebellar nuclei at the same side, from which the pathway is identical to that of the fibers from the horizontal canal, through the superior cerebellar peduncle to the cerebral cortex of both sides."

Pointing tests demonstrate the condition of the cerebellum, for there are correlated the centers governing equilibrium. The patient is seated in the chair used for turning tests and rests the forefinger of one hand on the forefinger of the examiner, who stands immediately in front of him with his right wrist pressed hard against his waist to prevent any lateral motion of his forefinger which is extended out with the palmar surface upward toward the patient. The patient then closes his eyes, and with arm outstretched and elbow stiff raises his hand above his head and brings it steadily down in the endeavor to again touch the forefinger of the examiner. This he readily does if the cerebellum is intact. The test is continued by the patient touching the forefinger of the examiner and then swinging his hand downward as far as possible and bringing it upward to again touch the examiner's finger. Also after touching the examiner's finger the patient swings his hand outward as far as possible in the horizontal plane and then brings it back again so that his forefinger again comes into contact with that of the examiner. All this is done first with the right hand and then with the left, the patient's eyes remaining closed during the tests. Should the patient fail to readily touch the examiner's forefinger, the direction and the extent of the spontaneous "past pointing" is noted as possibly indicating a cerebellar lesion. Spontaneous past pointing of the right hand to the right suggests a lesion of the inward pointing center in the right lateral cerebellar hemisphere. Spontaneous past pointing to the left suggests a lesion in the outward pointing center in the right lateral hemisphere.

If the patient is turned to the right ten times in ten seconds and the pointing tests repeated by the patient swinging his right hand up and bringing it downward to touch the examiner's finger, the hand in ascending and descending describes a V with its base downward, so that his finger "past points" the examiner's finger a considerable distance in the direction of the turning regardless of the position of the head.

When the test is repeated with the patient's left hand it will be found that the past pointing is less, because the vertigo produced by the turning will have had time to subside partly. However, the test is continued first with the patient's right hand, then with his left, then with his right; and so on, until he ceases to past point. The examination is continued by turning the patient to the left ten times in ten seconds instead of to the right, and the amplitude and duration of the resulting past pointing noted as before. If by this method the past pointing is normal or, rather, physiologic, it indicates that the labyrinth, the efferent and afferent nerve tracts, and the cerebellum are functionating properly. A departure from the normal indicates disturbance of one of these organs. However, if any past pointing by both hands results from the turning, even if very little, it indicates that the cerebellum is probably functionating properly, but if the labyrinth is normal, difficulty in forcing a way through the nerve tracts connecting these structures.

Because the vertigo and nystagmus are longer continued after syringing than after turning, pointing tests are more satisfactory after cold syringing than after turning. The right ear is syringed with water at 68° F. in the manner already described and the pointing tests applied both to the patient's right and left hands. Should there be produced less past pointing than normal, the head is tilted backward at an angle of 60 degrees so as to render the horizontal canals vertical. Should the pointing tests be normal under these circumstances, it indicates a lesion of the pontine angle involving the middle cerebellar peduncles, but not extending downward sufficiently to involve the inferior peduncles, because the nerve-fibers from the vertical canals traverse the middle cerebellar peduncles and those from the horizontal the inferior peduncles; and in pontine angle abscess there is generally sufficient pressure on the fibers from the cochlea to cause deafness. Because of the relative position of the fibers from the vertical and horizontal canals to the fourth ventricle increased pressure within the ventricle, as might result from an abscess in the temporal lobe pressing on the lateral ventricles, would affect the fibers from the vertical canals more than those from the horizontal, but would not affect the hearing.

The pointing tests are continued after syringing the left ear, and if any past pointing results, it is concluded that the left half of the cerebellum is functionating. If the past pointing is smaller than usual after syringing the left ear, the same inferences are made as regards a lesion, and its position in the nerve tracts of the left side as described above for the right side. According to Fisher:

"1. When the results of ear stimulation are nystagmus none, vertigo none, past pointing none, and falling none, we are obviously dealing with a destruction of the labyrinth of the eighth nerve produced either by a toxemia (acute or chronic), hemorrhage, inflammation, or a tumor. We, of course, have the corroborative evidence of a complete deafness in that ear. There is always present, beyond a doubt, a complete destruction of the labyrinth or eighth nerve when we have a picture of a dead auditory apparatus as well as non-responsive semicircular canals.

"2. Should stimulation of the horizontal semicircular canals produce nystagmus none, vertigo normal, past pointing normal, the lesion indicated is in the medulla oblongata, between Deiters' nucleus and the posterior longitudinal bundle.

"3. If stimulation of the vertical semicircular canals produces nystagmus none, vertigo normal, past pointing normal, and falling normal, the lesion indicated is in the posterior portion of the pons near the posterior longitudinal bundle.

"4. If stimulation of the horizontal semicircular canals gives nystagmus normal, vertigo none, and past pointing none, the lesion suggested is in the inferior cerebellar peduncle on that side, or at a point further up along the vestibulo-cerebello-cerebral tract in the pathway for dizziness.

"5. If stimulation of the vertical semicircular canals produces nystagmus normal, vertigo none, past pointing none, and falling none, the lesion indicated is in the middle cerebellar peduncle, or at some other portion of the vestibulo-cerebello-cerebral tract, higher up.

"6. If stimulation of the horizontal semicircular canals and also of the vertical semicircular canals produces nystagmus none, vertigo normal, past pointing normal, and falling normal, there is indicated a lesion of the posterior longitudinal bundle.

"7. If stimulation of the horizontal and vertical semicircular canals produces nystagmus normal, past pointing none, falling none, and vertigo none, it indicates a lesion of the cerebellar nuclei of that side where the fibers from the inferior and middle cerebellar peduncles come together, or in the upper portion of the pons where all these fibers again come together at the decussation of these fibers in the superior cerebellar peduncles."

Method of Examination for Disease of the Vestibular Apparatus.—The patient is first questioned as regards vertigo, tinnitus, and deafness. The nose, throat, and visible parts of the ear are then inspected. Impacted cerumen, if present, is removed. The hearing for each ear is tested by means of the voice, watch, and C fork. Weber's, Rinné's, and Schwabach's tests are employed and the hearing tested for high and low tones by means of forks and Galton's whistle. The eyes are then inspected for muscular paralyses or spontaneous nystagmus, which, if in a vertical direction, indicates a brain stem lesion. The patient then stands with his eyes closed and the inner surfaces of his feet in contact for about a minute (Romberg test). Any swaying or tendency to fall is noted; and if present, the head is turned first to the right and then to the left in order to ascertain if the position of the head changes the direction of the falling. If thought necessary, modifications of the Romberg test, such as walking with the eyes closed in a straight line 20 feet forward and then back; hopping on one foot with the eyes closed, etc., may be employed. The patient is examined for the presence of the girdle reflex. He stands with his eyes closed and his feet close together in front of the examiner, who attempts to overthrow him by pushing upon one shoulder toward the opposite direction, being careful, of course, not to actually throw the patient down. If the patient does not yield a satisfactory response to the test by stoutly resisting the effort to overthrow him, it indicates a lesion of the vermix. The patient is then examined for spontaneous past pointing. As already stated, spontaneous past pointing with the right hand to the right indicates a lesion of the right cerebellar center for inward pointing in the lateral hemisphere of the cerebellum. Spontaneous inward pointing with the right hand indicates a lesion of the outward cerebellar center for outward pointing. Similar inferences as regards the left lobe of the cerebellum may be drawn from spontaneous past pointing with the left hand.

The patient is now seated in the chair (Fig. 211) and the condition of the horizontal canals noted as regards nystagmus after turning to the right and then the left ten times in twenty seconds. The patient is then turned with his eyes closed first to the right and to the left ten times in ten seconds, and result as regards past pointing noted. He is questioned as regards sensations of falling or vertigo. If thought necessary the condition of the vertical canals are ascertained both for nystagmus and past pointing by turning the patient with his head bent forward at an angle of 120 degrees.

The right ear is now douched with water at a temperature of 68° F. and the length of time noted before nystagmus begins to appear. With a normal vestibular apparatus, as already stated, it should be about forty seconds. If its appearance is long delayed beyond this time, it indicates an apparatus weakened from some cause within the labyrinth or along one of the nerve tracts, as, for example, the pressure of a tumor. If after five minutes' douching, nystagmus fails to appear, it may be assumed that it will not appear if the douching is longer continued. The douching should be done with the head bent forward at an angle of 30 degrees in order to stimulate the vertical canal and should be continued for a little time after nystagmus first appears until it is well established. The patient then closes his eyes and the pointing tests are applied. The head is then bent backward at an angle of 60 degrees in order to bring the horizontal canals into a vertical position. The patient opens his eyes and the observer notes when the rotary nystagmus becomes horizontal, indicating that there is an endolymphatic current in the horizontal canals. The patient then closes his eyes and the pointing test is applied in order to ascertain the condition of the horizontal canals and the associated nerve tracts and centers. If the vertigo still continues, the patient leaves the chair and stands with his feet close together, and the direction in which he tends to fall is noted and also whether the direction of the falling is changed by turning the face either to the right or the left.

It should be noted that as the result of turning to the right or douching the right ear with cold water, if the vestibular apparatus is normal, the slow component of the nystagmus, the past pointing, and the falling all will be to the right, and in case of the left ear the slow component of the nystagmus, the past pointing, and the falling all will be to the left.

After a short interval of rest the patient's left ear is douched and the results noted in the same manner as described above for the right. Under certain circumstances it is better to corroborate the results obtained by douching with cold water by douching the other ear with hot water.

The observer as the result of the examination detailed above has sufficient data to apply the facts outlined by *Fisher* (p. 549). If the presence of an intracranial lesion is suspected the beginner should draw a rude diagram of the internal ears and the nerve tracts and centers in the pons, cerebellum, and cerebrum with which they are connected in order to better visualize these structures. He can then plot upon the diagram by means of plus and minus signs the condition of each structure as indicated by the examination as it proceeds.

Electric tests apply only to the auditory nerves and have no bearing on the labyrinth. According to Mackenzie, if a patient shows no reaction to either the turning or caloric tests, but a normal reaction to electric tests, a normal vestibular nerve and a destroyed labyrinth is probable. The galvanic test is usually made by the patient holding one sponge in his hand while the other is applied to the ear to be tested. In a normal ear nystagmus and vertigo result from the passage of 4 or 5 cathode or anodal milliamperes.

Fistula Test.—When a fistula leads into the external semicircular canals, if the labyrinthine contents are compressed by quickly squeezing a Politzer bag whose nozzle is fitted tightly into the meatus, vertigo and nystagmus toward the diseased ear is produced. Suction by means of the bag causes vertigo and nystagmus toward the sound ear. The nystagmus is in the opposite direction when the fistula is at the oval window.

Labyrinthitis may be circumscribed or diffuse. The circumscribed is either paralabyrinthitis, inflammation of the bony capsules; or perilabyrinthitis, inflammation of the perilymph spaces; or a combination of the two. Endolabyrinthitis, or inflammation of the endolymph spaces, never occurs independently. Therefore the diffuse form is either a combined peri- and endolabyrinthitis, that is *empyema;* or *panlabyrinthitis*, which is a combination of para-, peri- and endolabyrinthitis. Both the circumscribed and the diffuse forms may be either acute or chronic, exudative, plastic or necrotic, and the exudation serous or purulent. Paralabyrinthitis is sometimes followed by sequestration of a part or the whole of the bony capsule, but intracranial complications are not as frequent as in suppuration of the labyrinth. In paralabyrinthitis facial paralysis is the rule rather than the exception, and according to Neumann, Weber's test is lateralized to the diseased ear in paralabyrinthitis and the well ear in labyrinthine suppuration.

Pathology.—No undoubted case of primary labyrinthitis has been reported. The disease is either meningeal, tympanic, or metastatic in origin. The tympanic form is by far the most common and may result from scarlatina, cholesteatoma, tuberculosis, trauma, etc. The most common location of circumscribed labyrinthitis is a semicircular canal, usually the horizontal. Circumscribed inflammation of the cochlear usually involves the first half of the basal whorl. Infection through the oval window may result in a localized inflammation of the cisterna perilymphatica; which may spread to other perilymphatic spaces without involving those of the endolymph. Diffuse labyrinthitis may be such from the beginning or a circumscribed inflammation may break down its barriers and become diffuse. In some cases a circumscribed abscess at the fundus of the internal auditory canal in the subarachnoid space is walled off by the attachment of the arachnoid sheath of the nerve to the dural lining of the canal which is an anatomic peculiarity of this region. Purulent inflammation in the middle ear may induce *serous* inflammation in the labyrinth, or purulent inflammation in one part of the labyrinth may induce serous inflammation of another portion. Labyrinthitis ends either in recovery with restoration of function; healing with permanent changes or extension to the intracranial cavity; the route of infection being the internal auditory canal, the aqueductus cochlea, the aqueductus vestibuli, or along vessels of the fossa subarcuata.

Symptoms.—Stimulation of the cochlear nerve causes tinnitus, destruction, deafness. Stimulation of the static labyrinth causes vertigo, disturbances of equilibrium, nausea, vomiting, and a nystagmus toward the stimulated labyrinth (stimulated disharmony). Similar symptoms follow destruction of the labyrinth, but the nystagmus is directed to the *sound* side. (Destruction disharmony.) The vomiting differs from that caused by intracranial lesions, because it is never of the projectile type and is always accompanied by nausea. Even in diffuse suppuration the temperature is usually normal; therefore fever is usually indicative of commencing meningitis. At least 80 per cent. of necrotic cases are complicated by facial paralysis. The tendency to fall is in the direction of the slow component of the nystagmus. If a nystagmus to the right exists, the body will tend to fall to the left. If the face is turned to the right shoulder the body will tend to fall forward; toward the left shoulder, backward. This is not the case when the disturbances of equilibrium are not of vestibular origin.

Circumscribed labyrinthitis causes symptoms of stimulated disharmony of sudden onset and often transient duration, brought on by stooping, straining, or moving the head rapidly. There may be spontaneous nystagmus. Rotation shows both labyrinths functionating normally and the caloric and fistula tests are positive.

Diffuse serous labyrinthitis may occur after a radical mastoid operation, removal of polypi, or even spontaneously as the result of circumscribed disease. After operation it occurs in from one to three days. Destructive disharmony resulting from mechanical injury of the labyrinth occurs at once. There is great diminution in hearing and a disposition to lie on the sound side so that the eyes may be directed toward the slow component of the nystagmus; when these symptoms last for one or two weeks, as they sometimes do, there usually results some permanent loss of function. However, even at the height of the attack there is usually reaction to either the turning, caloric, or fistula test, or perhaps to all of these tests, and so long as some function remains infection of the intracranial contents rarely or never occurs. Moreover, in cases that go on to suppuration, when all function has been destroyed, there is an interval of some hours or days before the infection extends to the meninges, as it usually does.

Diffuse suppurative labyrinthitis is either *manifest* or *latent.* In contradistinction to diffuse serous labyrinthitis the symptoms are most violent. There is sudden complete deafness; persistent nausea and vomiting; rotatory nystagmus to the sound side and disturbances of equilibrium to the extent that the patient is unable to walk without assistance and lies in bed upon the side of his sound ear. The *diffuse latent* form is as dangerous as it is insidious. There is frequently neither history nor symptoms except there is complete deafness and the caloric and fistula tests are negative. If the disease has lasted so long that the intralabyrinthine spaces are filled with a new bone formation, the after-turning nystagmus of the sound side equals that of the diseased side, but both are shorter than normal. The same anomalous reaction occurs after sequestration in necrosis. Except in these cases, when latent suppurative labyrinthitis exists, polypi extraction or even a radical mastoid must be looked upon as an *incomplete operation and dangerous,* because of the possibility of intracranial extension of the labyrinthine infection.

Differential Diagnosis.—Labyrinthine inflammation must be differentiated from hysteria, affections of the auditory nerve, meningitis, and abscess or tumor of the cerebellum. In *hysteria* the middle ear may show no pathologic changes. If nystagmus is present it is not of the vestibular type; nor are the disturbances of equilibrium of that type, that is, the body will have a tendency to fall backward or forward or to the side, according to no definite rule, and not *always* toward *the direction of the slow component of the nystagmus.* Deafness may be simulated, but the static labyrinth will react to the functional tests. The diagnosis between affections of the auditory nerve and labyrinth are made by the caloric and galvanic tests. The caloric test determines the comparative susceptibility of the two labyrinths; the galvanic, of the two auditory nerves. If nystagmus toward the side of the destroyed labyrinth develops after a labyrinthine operation, it indicates either disease of the other labyrinth, meningitis, or cerebellar abscess. If functional tests exclude disease of the unoperated labyrinth, in the presence of intracranial symptoms, exploration of the posterior fossa and perhaps cerebellum is justifiable. When a labyrinth has been destroyed by disease and not operated on, the diagnosis from meningitis or cerebellar abscess is never easy. However, there is temperature and pressure symptoms, and turbid cerebrospinal fluid obtained by lumbar puncture. In cerebellar abscess, tumor, or localized meningitis there is spontaneous nystagmus toward the diseased side. Therefore if there be spontaneous nystagmus for a time toward the well side, succeeded by nystagmus toward the diseased side, cerebellar abscess is probable. Nystagmus in a normal ear suggests cerebellar tumor; with suppuration of the middle ear, deafness, and no response to the caloric test, cerebellar abscess is probable. The disturbances of balance do not diminish in cerebellar abscess as in labyrinthitis.

Treatment.—Most cases of labyrinthitis recover without operative treatment; some with complete or partial restoration of function. The fatal cases are usually of the diffuse purulent type, but even such cases heal spontaneously. This is especially true of cases complicating scarlet fever. More frequent than spontaneous healing is a subsidence into a latent chronic stage, which may last for years and finally produce serious intracranial complications, especially if a middle-ear operation be done. No case of circumscribed labyrinthitis should be operated on unless a complete operation be done, because the breaking down of the barriers that nature has erected to the spread of the disease is extremely dangerous without the adequate drainage of a complete operation. A radical mastoid should not be done unless urgent where diffuse, purulent labyrinthitis is present, but many chronic and subacute cases admit of an interval of some days between the radical mastoid operation and exenteration of the labyrinth should meningeal symptoms develop. Alexander believes that no extensive operation should be done on the labyrinth without exposing the dura and exploring the region of the sacculus endolymphaticus, as extradural abscess is common in this locality. When circumscribed labyrinthitis occurs in chronic suppuration, cholesteatoma is usually present and a radical mastoid is therefore necessary. If during the operation the fistula, usually at the eminence of the external semicircular canal, is discovered, it should *neither be probed nor cureted*, but the patient should be carefully watched for the occurrence of either diffuse serous or purulent labyrinthitis, which usually occurs, if at all, on the second or third day after the operation. If there is complete loss of hearing and negative functional tests with some elevation of temperature, the labyrinth should be exenterated in the hope of preventing the spread of the infection to the cranial cavity. On the other hand, cases of diffuse serous labyrinthitis usually subside in a week or two and it is not necessary to operate.

The occurrence of facial paralysis in chronic suppuration when the functional tests are negative is positive proof of a latent labyrinthitis.

Non-operative treatment of labyrinthitis consists simply of rest in bed, the patient determining for himself the position best suited for diminishing vertigo and nystagmus. He should remain in bed as long as vertigo exists; from a few days to several weeks. Bromids, 10 grains three or four times a day, lessen the nervous irritation, and galvanism sometimes relieves the vertigo. An electrode is placed in front of *each* ear, the anode on the side toward which the nystagmus is directed.

Labyrinthine operations consist of labyrinthotomy or *opening* the labyrinthine spaces, and labyrinthectomy or removal of the labyrinth as far as practical. In the first group belong the operations of Hinsberg, Richards, and Bouquets; to the second those of Jansen and Neumann. The simple enlargement of a fistula is of no value for draining an infected labyrinth, and a wide opening of the vestibule and basal whorl of the cochlea is necessary. When there is involvement of the bony capsule a labyrinthectomy should be done. In sequestration of a portion of the labyrinth, the sequestrum is removed and the rest of the labyrinth left intact in order not to destroy protective granulations. There has recently developed a marked tendency toward conservatism. Duel, Dench, and Border justify the performance of a radical mastoid operation in the presence of diffuse purulent labyrinthitis under certain circumstances. Duel thinks it all right in acute otitis cases provided all concussion is avoided, and Dench states that the single operation is justified when the labyrinthritis is latent and there are no labyrinth symptoms. Dench and many other authorities seem to think that the Neumann operation is advisable only when meningitis is threatened or is present.

Hinsberg's Operations.—The oval window is enlarged at the expense of its lower margin after removal of the stapes, if present, the chisel being directed toward the round window so that the bridge of bone between the oval and round windows is removed. He sometimes also removes the promontory exposing the basal whorl of the cochlea.

Neumann's operation is done after a complete radical mastoid. The inner table over the lateral sinus is removed with a large gouge and also the intervening bone over the dura forward to the labyrinthine capsule either with chisel or rongeur. The dura is now carefully separated from the posterior surface of the pyramid, which is somewhat difficult because of the depressions into which processes of dura extend. The posterior surface of the pyramid is removed layer by layer with a gouge. A deviation of the chiseling upward endangers the superior petrosal sinus; downward, the jugular bulb; outward, the facial nerve. The chiseling is continued forward until the pyramid of bone containing the semicircular canals is removed and the seventh and eighth nerves are exposed in the internal auditory canal. As the chiseling proceeds there appears at the level of the round window the convexity of the posterior semicircular canal. There next appears the lower limb of the posterior semicircular canal on a level with the round window and the common limb of the posterior and superior canals on a level with the lower margin of the oval window. A third opening soon appears between the other two, the posterior limb of the external canal. A probe passed either through the common limb or the external canal enters the vestibule readily. The external canal is uncapped by the chisel until the vestibule is opened. Jansen advises that the operation cease at this stage, but Neumann continues the chiseling of the posterior surface of the petrous pyramid until the posterior wall of the internal meatus is removed. If the dura is accidentally torn the opening is enlarged to ½ inch, as only small tears are dangerous. Starting at the oval window and directing the stroke of the chisel downward and forward, the lower half of the basal whorl of the cochlea is opened, and when the cochlea is a mass of sequestra, pus, and granulations, it is scraped out with a curet.

After-treatment is the same as after a radical mastoid operation. The bone cavity fills with granulations and becomes covered by epidermis.

FORMULAS

AQUEOUS DETERGENTS, SPRAYS, AND WASHES USED TO CLEANSE MUCOUS MEMBRANES

DOBELL'S SOLUTION.

1. ℞.	Sodii bicarbonatis Sodii biboratis	āā ʒj;
	Acidi carbolici	gr. xlviij;
	Glycerini	ʒiii½;
	Aquæ	Oij.—M.

The above is stated to be Dr. Horace Dobell's original formula. Diluted with an equal amount of water it may be used either as a spray to cleanse the mucous membrane of the nose, throat, and larynx, or may be prescribed as a wash for the patient's use at home. The temperature of a spray is not materially altered by that of the fluid in the atomizer-bottle, but when used as a nose-wash with a syringe or douche or by "sniffing up the nose" the solution should be warmed to about 110° to 130° F. Higher temperatures are sometimes of advantage in acute inflammation.

2. ℞.	Sodii bicarbonatis Sodii biboratis	āā ʒj;
	Sodii salicylatis	gr. iij;
	Menthol Thymol	āā gr. j;
	Glycerini	f℥j;
	Aquæ torridi	f℥iv.—M.

Sig.—Add enough water to make 1 quart and use with an atomizer or as a nose-wash.

This formula yields a wash nearly as unirritating as Dobell's solution, and it has not the objectionable odor of carbolic acid. The concentrated wash is sufficiently antiseptic to preserve small anatomic specimens indefinitely, and the diluted wash will preserve them for a considerable time. The solid ingredients of the wash may be compressed into a tablet of such size that one added to 4 tablespoonfuls of water will make a wash of the requisite concentration. Under such circumstances borax should be substituted for the glycerin of the formula in sufficient quantity to yield a wash of specific gravity of 1020, because a wash of greater or less specific gravity than 1020 is irritating to the nasal mucous membrane.

Both Dobell's solution and the formula above should be compounded at least three or four days before being used. During this time carbonic acid gas escapes, and glyceroles and other compounds are formed that render the solutions much more bland and unirritating to the nasal mucous membrane. Of the two, Dobell's solution, probably because of the sedative qualities of dilute solutions of carbolic acid, is less irritating, but has the disadvantage of the smell and taste of carbolic acid, which is very objectionable to some patients, especially ladies. The following is a good detergent wash:

3. ℞. Liquor antiseptici alkalinis (N. F.).... f℥iv.

Sig.—Dilute with 7 parts of water and use as a spray for cleansing the nose.

4. ℞. Liquor antiseptici.................. f℥iv.

Sig.—Dilute with 7 parts of water and use with an atomizer or nasal syringe.

This preparation has an acid reaction and is somewhat irritating to nasal mucous membranes, but for this very reason is sometimes prescribed in atrophic rhinitis.

5. ℞.	Potassii chloridi..............	0.2 gm. or gr. iij;
	Sodii bicarbonatis............	0.2 gm. or gr. iij;
	Sodii chloridi................	9 gm. or. gr. cxl;
	Aquæ...............q. s. ad.	liter j or f℥xxxiii⅓.—M.
		(Ringer.)

Sig.—Normal salt solution for intravenous injection, hypodermoclysis, etc.

Normal salt solution is used as a detergent wash. For this purpose it is probably less effectual than Dobell's solution and other bland alkaline washes. In surgery it is sometimes used for irrigation instead of sterile water. In threatened collapse from hemorrhage or other causes 1 or 2 pints may be injected into the median cephalic vein, or fluid may be added to the general circulation by rectal injection (enteroclysis), or by subcutaneous injection into the cellular tissue of the thigh, abdomen, or buttocks (hypodermoclysis).

6. ℞.	Mentholis..........................	gr. viij;
	Olei gaultheria.....................	gtt. x;
	Olei menthæ viridis.................	gtt. iij;
	Natrii bicarbonatis Natrii biboratis Natrii chloridi .... *āā*	ʒx.—M.

Sig.—Add a teaspoonful to a pint of water and make a solution to be used from time to time diluted with an equal amount of hot water as a nose-wash with a syringe. (Useful in atrophic rhinitis.)

7. ℞.	Acidi borici (crystals)...............	℥ij–iv;
	Aquæ fervidi.......................	f℥iv.—M.

Sig.—Place the boric acid in a wide-mouthed bottle and add the warm water. Syringe the ear with this saturated solution and add hot water as required from time to time to secure a saturated solution of suitable temperature for syringing the ear. As the boric acid crystals dissolve, add more, so that a portion always remains undissolved.

Useful in the "cleansing treatment" of chronic otorrhea. However, in most cases with extensive destruction of the drum-head, better results are secured by home syringing with corrosive sublimate (1 : 5000 to *1 : 10,000*).

8. ℞. Hydrargyri bichloridi................ gr. viiss;
Aquæ destillatæ..................... Oj.—M.
Sig.—Bichlorid of mercury solution (1 : 1000).

Bichlorid of mercury solutions should rarely, if ever, be used in the nose or accessory cavities, as they are extremely irritating even when very dilute. Because under ether an unknown quantity may pass through the eustachian tube and be swallowed it is better to irrigate mastoid wounds with sterile water or normal salt solution. When the operation is completed only enough bichlorid solution to blanch the tissues and prevent capillary oozing may be used with safety. Periostitis and inflammation of the cellular tissue, after mastoid and other operations, is probably best treated by saturating the dressings with bichlorid solution. For this purpose 1 : 3000 or 1 : 5000 solutions are strong enough, as some skins are so sensitive as to blister if a more concentrated solution is used. If deemed necessary the attic may be syringed with an intratympanic syringe with 1 : 1000 bichlorid without any decided reaction occurring, but for the patient's home syringing, in the so-called "cleansing treatment" of chronic otorrhea, stronger solutions than 1 : 5000 or 1 : 10,000 should not be employed. According to McClintock, mercuric iodid and bicarbonate of sodium yield a solution of greater germicidal power, and at the same time less irritating to the tissues than bichlorid of mercury. The author has used the following 1 : 5000 solution for syringing the attic:

9. ℞. Hydrargyri biniodidi.................. gr. viiss;
Sodii bicarbonatis................... ℥vss;
Aquæ......................q. s. ad. Oj.—M.
Sig.—Diluted with 5 to 10 parts of water for syringing the attic.

10. Hydrogen dioxidi.

Commercial hydrogen peroxid is sold usually as a 3 per cent., equal to a 15 volume, solution of the gas. Its strength can readily be increased by evaporating the solution in a shallow vessel at a temperature considerably below the boiling-point, as under such circumstances the evaporation is much more rapid than the decomposition of the solution, and a strength of 100 volumes or even more is readily obtained. The stronger solutions are *caustics*, quickly destroying living tissue. The ordinary 15-volume solution is very irritating to the mucous membrane of the nose and pharynx and, therefore, it should not be prescribed indiscriminately in catarrhal affections.

Its chief use in rhinology and otology is for the removal of pseudomembranes, the cleansing of pus cavities, and as a hemostatic, but when used for any of these purposes its irritating qualities should be borne in mind.

When brought into contact with organic substances hydrogen peroxid is decomposed with the liberation of nascent oxygen, which unites with the organic substance, often greatly increasing its bulk. When applied to a pseudomembrane in the pharynx the membrane is not only softened and decomposed, but its increase in bulk greatly facilitates its removal. For the removal of pseudomembranes the peroxid is best applied by means of a swab, made by wrapping cotton about the end of an applicator. In this manner the peroxid may be not only rubbed into the pseudomembrane, but the rubbing assists in detaching it from the mucous membrane. Of course the "rubbing" should be done with judgment and gentleness, and it is rarely necessary to use a solution stronger than 3 per cent. The action of the swab may be assisted, if necessary, by spraying the membrane, if desirable, by means of an atomizer.

For *cleansing* the middle ear, the antra of Highmore, or other cavities of pus, 3 per cent. peroxid, diluted with 1 or 2 parts of water, is generally sufficiently strong. Care should be used in injecting peroxid into a cavity that there is an opening sufficiently large to permit the easy escape of the gases generated by the decomposition of the peroxid. Should this not be the case, the pressure generated may be sufficient to cause great pain and, in the case of the middle ear, syncope and vertigo. In fact, it is injudicious to inject peroxid through a small opening in the drum-head or a narrow sinus leading upward into the attic and mastoid antrum. It is stated that in the attic peroxid is capable of doing more harm than good by carrying pus into localities previously unaffected during its ebullition and thus spreading the infection. In the antra of Highmore peroxid is valuable for loosening and disintegrating masses of adherent mucopus.

As a *hemostatic* peroxid acts by causing an immediate clotting of the blood with which it is brought into contact, and the clot formed under such circumstances is very bulky and firm. When pledgets of cotton soaked in peroxid are inserted into a bleeding nostril the blood coming into contact with the peroxid is immediately clotted, and until the peroxid is exhausted the more bleeding the more clotting, and consequently the more pressure upon the bleeding vessel. Remedies like adrenalin, that cause contraction of the blood-vessels, are generally of little use for controlling nasal hemorrhage, because the flow of blood prevents them from coming into contact with the nasal mucous membrane and producing any effects.

LOCAL ANESTHETICS

11. Cocain.

When it is desired to produce local anesthesia of any portion of the interior of the nose a cotton pledget saturated with a 1 : 1000 adrenalin solution should be dipped into $\frac{1}{2}$ grain of powdered cocain and rubbed into the parts to be operated on two or three times at intervals of about six minutes. To anesthetize the septum for a submucous resection, the powdered cocain is first rubbed into the mucous membrane of both sides of the septum in the manner described above, and then after an interval of about six minutes pledgets of absorbent cotton made as thin as possible are saturated with a 1 : 1000 solution of adrenalin and allowed to remain in contact with the mucous membrane on each side of the septum for six minutes. The powdered cocain is then again rubbed into the septal mucous membrane and the parts are ready for operation. It is unnecessary to use more than $\frac{1}{2}$ grain of cocain in this manner to produce complete anesthesia. Cocain "flakes" are furnished by some of the manufacturing chemists and are more convenient than the powder. Slight local anesthesia to facilitate the passage of an instrument or shrinking of the tissues to secure a better inspection of the interior of the nose may be secured by a 1 to 2 per cent. solution.

Anesthesia of the larynx is produced by the application of a 10 per cent. cocain solution in 1 : 1000 adrenalin to the laryngeal mucous membrane by means of a cotton-tipped applicator, and repeating the procedure after an interval of two or three minutes. The sensibility of the larynx should then be tested with a cotton-tipped applicator dipped in a 10 per cent. solution of cocain from time to time, until the applicator can be moved about freely in the larynx without producing a reflex spasm, as there is little use in beginning an operation on the larynx when every touch of an instrument is followed by spasm or retching and gagging. Anesthesia of the larynx, produced by the application of a solution of cocain, appears quickly after the application and lasts only a short time. Apparently cocain can be used more freely in the larynx than in either the nose or ear without danger of poisonous effects.

Watery solutions are not absorbed with sufficient facility by the skin to render their use inside the auditory canal at all satisfactory for producing local anesthesia. Diminished sensibility of the drum-head and of the wall of the canal may, however, be secured by a 10 per cent. ointment of *cocain in lanolin*, and this ointment is probably better than preparations of morphin, atropin, etc., for the relief of the pain of otalgia. When prescribed for this purpose it is simply inserted within the meatus, due care being exercised when the drum-head is absent not to use a sufficient quantity to produce a poisonous effect. When the drum-head is present the ointment will remain for days in contact with it and be slowly absorbed. Its sedative effects are, under such circumstances, followed by no reaction.

For the production of local anesthesia for the *removal of aural polypi* a pledget of cotton saturated with a 10 per cent. solution in adrenalin may be allowed to remain for five minutes in contact with the parts. This method, however, is not adequate for the production of local anesthesia in removal of the ossicles or, in fact, any of the more painful and tedious intratympanic operations, which ordinarily necessitate the almost complete local anesthesia resulting from the subcutaneous injection of ½ grain of cocain and 10 drops of adrenalin solution in an ounce of normal salt solution in several places beneath the skin of the canal at the junction of the bony and cartilaginous portions. An ordinary hypodermic syringe with a small needle connected by a bayonet-shaped metal tube 3 inches long is convenient for these injections; 10 or even 20 minims may be required to produce complete anesthesia of the middle ear.

For local anesthesia of the tonsils the same syringe and solution answer every purpose. For tonsillotomies a few drops are injected in several places beneath the mucous membrane at the edge of the pillars and then a small amount beneath the tonsil. According to some writers equally satisfactory results are secured by painting the pillars with 10 per cent. solution and injecting normal salt solution. Instead of cocain, novocain in ½ per cent. solution may be substituted.

Yankauer advocates injecting a few drops of a 1 per cent. solution of cocain into the neighborhood of the accessory palatine foramina, by which means the entire region supplied by the middle and posterior palatine nerves, including the tonsil, is anesthetized. The point of the needle is inserted obliquely through the mucous membrane to the bone at a point 1 cm. above and 1 mm. posterior to the posterior edge of the gum of the third molar, or, should this tooth be absent, 1 cm. obliquely upward and forward from the tip of the hamular process.

For relief of earache and the production of sufficient local anesthesia for a paracentesis or the removal of an aural polypus Ballance advocates instilling into the ear a drop of the fluid resulting from the mixture of equal parts of carbolic acid, menthol, and cocain crystals. The resulting fluid is not caustic, as might be inferred from its composition, but the degree and duration of the anesthesia resulting from its instillation into the ear is inferior to that produced by subcutaneous injections of cocain and adrenalin, and for the cocain in the formula may be substituted camphor with apparently equally good results as far as alleviating otalgia is concerned. Smilie states that coryfin is superior to the menthol-phenol-cocain formula for the relief of pain.

Eucain, alypin, stovain, and several other substances are used as substitutes for cocain, the claim being that they possess anesthetic qualities similar to those of cocain and are less liable to produce toxic effects.

In cases that are known to be sensitive to the toxic effects of cocain it would be well to employ one of these substances. The fact that neither alypin nor stovain contract the tissues render them valuable anesthetics in operations upon posterior nasal hypertrophies.

Hypodermic tablets can be obtained from manufacturers containing suitable amounts of synthetic cocain and adrenalin to make solutions for either surface applications or hypodermic injections. These synthetic products are said to be less toxic than cocain and adrenalin and equally satisfactory for producing local anesthesia.

The symptoms of cocain poisoning are rapid and shallow respiration, feeble or absent pulse, mental anxiety, restlessness and, finally, unconsciousness. Death may occur from asphyxia after feeble respirations of the Cheyne-Stokes type. According to Engstad the inhalation of ether by the drop method up to mild anesthesia is the most prompt and effective antidote. Ether at first stimulates the vasomotor system, is a tonic to the heart muscle, and increases the pulmonary circulation.

ASTRINGENTS

Astringent sprays for the nose, pharynx, and larynx of zinc and copper sulphate, alum and zinc sulphocarbonate may be used of a strength of 5 to 10 gr. perchlorid of iron, nitrate of silver, and tannin in the strength of 3 to 5 gr. per ounce to decrease congestion and lessen secretions. Usually zinc sulphate yields the best results. Alum has been a favorite for a long time, but its use as an astringent spray for the larynx has been superseded to a considerable extent by alumnol, which is less irritating and can be used in strengths of 10 to 20 gr. to the ounce. Astringent sprays are not frequently employed in the nose and should be used after cleansing the nasal mucous membrane with a detergent. The astringent is best dissolved in oil or, better still, used as an ointment by the patient, who should throw his head well back and retain it in that position until by gentle sniffing the ointment melts its way through the nasal passages and is hawked into the mouth and expectorated. If preferred, the astringent may be incorporated with cocoa-butter and employed as a nasal suppository.

12. ℞. Zinci sulphatis.................... gr. x–xx;
Glycerini.......................... fʒij;
Aquæ....................q. s. ad. f℥j.—M.

Useful as an application by means of a brush or a dossil of absorbent cotton to the pharynx and larynx in subacute and chronic laryngitis, and to the nasopharynx in subacute nasopharyngeal catarrh.

13. ℞. Tincturæ ferri chloridi }
Glycerini } .... *āā* f℥ss.—M.

Useful as an application to erosions over varicose vessels in chronic nosebleed.

14. ℞. Acidi gallici .... gr. v–x;
Petrolati .... ℥j.—M.

Sig.—For patient's use in recurrent nasal hemorrhage and in the chronic rhinitis of children. A piece the size of a pea should be inserted in each nostril night and morning.

15. ℞. Pil. atropiæ sulphatis................. gr. $\frac{1}{200}$.
Sig.—One every three or four hours.

Useful in controlling excessive nasal secretion in coryza, hay-fever, and nasal hydrorrhea.

16. Alcohol, 95 per cent.

Useful as an application to the tympanic mucous membrane when it is covered by granulations and small polypi. For the patient's use at home, to cause shrinking of granulations and polypi, alcohol, diluted with an equal amount of water, may be prescribed, to be dropped into the auditory canal several times a day. Should this cause only momentary smarting, the patient should on the next occasion use alcohol 2 parts diluted with water 1 part, and so on until undiluted 95 per cent. alcohol is dropped into the ear four or five times a day. Practically the ear will then contain alcohol all the time. It acts as a dehydrating agent on polypi and exuberant granulations, destroying their vitality and promoting cicatrization. Its value as an antiseptic also plays its part in bringing about a good result. Boric acid dissolved in the alcohol is sometimes prescribed for the patient's use, but, as under such circumstances when the alcohol evaporates the boric acid is deposited as sharp-pointed crystals on the mucous membrane, it is probable that the boric acid is a source of irritation. The same may be said to a less degree of the addition to the alcohol of other dehydrating agents like glycerin and sulphuric ether. In order to secure the best results from instillations of alcohol the patient should lie down with the affected ear uppermost and then straighten the canal by pulling the auricle upward, outward, and backward. The canal should then be *filled* with alcohol, which should be forced into the tympanum by manipulating the tragus. This procedure also serves to float outward particles of pus and other materials. Polypi of considerable size may be destroyed by this method, but it is somewhat tedious if the polypi are large, and hence such growths should be removed by snare or forceps. Alcohol is also a valuable antiseptic and astringent in the treatment of inflammation of the accessory sinuses, pharynx, and larynx. In the accessory sinuses it is used with the same precautions as in the middle ear.

17. Liq. argenti nitratis, 2 to 20 per cent.

Silver nitrate (10 per cent.) is useful as an application to the pharynx or tonsils in acute pharyngitis or tonsillitis. When applied sufficiently early it will often abort the disease if used two or three times a day. When painted upon the lateral walls of the pharynx it produces at once a feeling of relief and comfort which persists for some time; when painted upon the posterior wall of the pharynx, a sensation of dryness and great discomfort. Hence it should not be used in this portion of the pharynx except for touching small areas of granulation tissue, etc. However, 2 per cent. solutions are permissible.

Solutions of silver nitrate (20 per cent.) also may be used as an astringent application to small polypi and exuberant granulation tissue in the tympanum. However, for this purpose it is far inferior to strong alcohol. Even the solid stick of silver nitrate when applied to granulations in the ear produces only a superficial destruction of tissue, and in this respect is far inferior to chromic or trichloracetic acids.

18. Protargol.
19. Argyrol.

The above are two of the best of the organic compounds of silver. Of the two, argyrol is probably the more valuable in controlling inflammations of mucous membranes. Protargol may be used as a spray to the pharynx or larynx in 10 per cent. solutions and argyrol in 20 per cent. solutions. Neither stain the skin, but each produce ugly stains of linen, that of argyrol being easily removed by soaking in bichlorid solution. They stop up atomizer tubes somewhat quickly, and hence are not well adapted for patients' use at home. Protargol and argyrol, when applied to mucous membranes, are astringent antiseptics, are nearly devoid of the irritating effects of silver nitrate, and penetrate the tissues more deeply. Argyrol in 5 per cent. solution is especially serviceable in the recurrent attacks of otorrhea where the drum-head has been destroyed. If applied at an early stage of the attack a single application by means of a cotton-tipped probe will sometimes abort the disease. If more than one application is required, it should be repeated every day. It is valuable as a non-irritating antiseptic injection by means of Blake's cannula into the attic of the tympanum in attic otorrhea, often bringing about a cessation of the discharge.

20. Tr. benzoini comp.

Formerly the compound tincture of benzoin was somewhat popular as an application to the nasal mucous membranes, either full strength or diluted with an equal amount of glycerin as a mild antiseptic astringent and deodorizer. Gauze moistened with the tincture will remain for several days within the nose without becoming fetid. The odor of a foul-smelling otorrhea can be corrected by mopping the canal and middle ear dry and applying compound tincture of benzoin every two or three days.

21. Aluminum acetate.................... 1 to 2 per cent.

May be used as a moist dressing in acute inflammation of the concha and auditory canal and to the skin of the nose after subcutaneous injection of paraffin, erythema, etc.

ALTERATIVES

22. ℞. Hydrargyri bichloridi............... gr. j;
Potassii iodidi..................... ʒij;
Aquæ.............................f℥iij.—M.
Sig.—1 to 3 teaspoonfuls after meals.

This formula, sometimes called "1, 2, 3 mixture," may be ordered when it is desired to employ the mixed treatment in syphilis.

"Iodid of potassium and sodium are very diffusible and are rapidly excreted, setting free nascent oxygen and iodin at the points of elimination. They are remotely irritant to the mucous membrane. They induce great waste and rapid elimination of waste products, causing anemia, emaciation, and depression. Mercury salts in small doses are blood tonics, improving the general condition, increasing the number of red corpuscles and body weight. They soon, however, begin to promote waste by stimulating the lymphatic system." (Wilson.)

23. ℞. Tablet triturat. hydrarg. protiodidi.... gr. ¼.
Sig.—1 tablet may be taken three or four times a day or even oftener, with a sufficient quantity of opium, if necessary, to prevent diarrhea.

Useful in the treatment of primary and secondary syphilis.

24. Salvarsan is a name given by its discoverer Ehrlich to an arsenical compound, probably the most active and speedy antisyphilitic known. In some primary cases a single injection has apparently brought about a cure. During the secondary and tertiary periods relapses are the rule and injections should be repeated as required. In some tertiary cases the results are inferior to those obtained by mercury and iodid of potassium; but in most instances a single injection has approximately the same result as four or five months' treatment by other methods. As salvarsan is highly poisonous the technic should be thoroughly mastered before attempting to use it.

25. ℞. Syrupus acidi hydriodici (N. F.).
Containing 1 per cent. HI by weight. Prepared from diluted hydriodic acid, it is of definite strength and does not readily decompose if properly protected against the atmosphere and the light.
Sig.—A teaspoonful in a wineglassful of water after meals.
Alterative; substitute for the alkaline iodids.

26. ℞. Hydrargyri cum cretæ.............. ʒj.
Sig.—1 to 4 gr. three times a day. Gray powder is sometimes useful in the treatment of infantile syphilis.

27. Dionin.

Dionin has been used by Randall and others to stimulate the circulation in middle-ear catarrh and thus aid the absorption of scar tissue, cicatricial bands, adhesions, etc. One or two minims of a 2 to 4 per cent. solution should be blown through a eustachian catheter by means of a Politzer bag. The fluid enters the eustachian tube as a coarse spray, some of which, when the tube is dilated in the advanced stages of middle-ear catarrh, reaches the tympanum. Congestion of the drumhead indicates that the remedy has reached its goal. Improvement as regards hearing and tinnitus appear after several applications, which are repeated at intervals of three or four days.

As the sedative dose of dionin by the mouth is about 7 grains, it is a comparatively safe drug to use in the manner described. It sometimes causes transient vertigo as any watery solution would do if blown into the middle ear through a catheter. In Randall's practice twenty applications complete the course; which, after an interval, may be repeated.

28. ℞. Thiosinamin.

Favorable results are reported from this remedy as a resolvent in chronic catarrh of the middle ear in doses of ½ to 1½ gr. two or three times a day. It is said to promote the absorption of newly formed fibrous tissue and hence relieve tinnitus and improve the hearing. It is given in capsules or tablet triturates; or hypodermically, 1 or 2 gr. every third day.

CAUSTICS

With the exception of the galvanocautery the caustics most employed in rhinology and otology are chromic and trichloracetic acids. As the destruction of tissue produced by applications of even the solid stick of nitrate of silver is very superficial, it scarcely can be considered a caustic.

Battey's solution is sometimes used as a mild caustic to destroy hypertrophied follicles in follicular pharyngitis. The formula is as follows:

29. ℞.	Iodin resublim	gr. clx;
	Phenol	gr. ccxl;
	Glycerini	f℥vj.—M.

Owing to the anesthetic effects of the carbolic acid, simply touching four or five hypertrophied follicles gives little pain or subsequent uneasiness. The remedy may also be used to contract hypertrophied tonsils by wrapping a few fibers of cotton about the end of an applicator and after dipping in the solution passing the applicator to the bottom of a crypt, or 1 or 2 drops injected into the crypt with a suitable syringe. Three or more crypts in each tonsil should be treated at intervals of a week or ten days.

30. ℞.	Zinci chloridi	ʒj;
	Aquæ destil	℥j.—M.

Useful in cauterizing the ulcers of malignant growths to secure healing or at least diminish pain and fetor. The application should be preceded by cocainization.

Carbolic acid is sometimes used as a mild caustic to destroy granulations in the middle ear. Either the crystals, to which a sufficient amount of glycerin has been added to render them fluid, or one of Calvert's solutions may be applied by means of a cotton-tipped probe to the exuberant granulations. Care should be exercised not to apply any of the carbolic acid to the skin of the canal. After a few moments alcohol should be dropped into the ear to check further action of the acid and the parts mopped dry and boric acid insufflated.

Various methods of employing trichloracetic acid and chromic acid as caustics have already been described in the text.

COUGH MIXTURES

Although remedies designed to affect the respiratory tract are best administered by means of an atomizer or nebulizer, and when that is impossible or inconvenient, in the form of a lozenge, yet the cough mixture still retains at least a measure of its former popularity. The following formulas are effective and sometimes convenient to prescribe:

31. ℞. Syrupi ipecacuanhæ.................. fʒss;
Syrupi scillæ...................... fʒvj;
Liq. potass. citratis.................. f℥j;
Mucil. acaciæ...............q. s. ad. f℥iij.—M.
Sig.—A teaspoonful in water every three hours.

Useful for controlling the coughs of children.

32. ℞. Ammoniæ bromidi.................. ℥ss;
Potassii cyanidi..................... gr. iss;
Ext. pruni virginiani fl............... f℥ss;
Ext. grindelia robustæ fl.............. fʒiij;
Elixir adjuvantis.............q. s. ad. f℥iv.—M.
Sig.—A teaspoonful in water four times a day.

Useful in the so-called "useless or dry cough" of nervous individuals due to pharyngeal irritation.

33. ℞. Morphinæ sulphatis.................. gr. ss–ij;
Potassii cyanidi..................... gr. iij;
Acidi sulphurici aromatici............ fʒj–ij;
Syrupi pruni virginianæ.....q. s. ad. f℥iij.—M.
Sig.—A teaspoonful every two or three hours if required to prevent coughing.

Useful as an anodyne, but somewhat stimulating cough mixture.

34. ℞. Tincturæ gelseminii }
Tincturæ lobeliæ } ....*āā* ℥j;
Potassii bromidi..................... ℥ss.—M.
Sig.—20 drops in water every three hours. (Burnett.)

The above is said to be almost a specific as regards relief in asthma.

35. ℞. Elixir terpini hydratis cum codeina (N. F.).
4 c.c., or 1 fl. dr., representing 0.06 gm. (1 gr.) terpin hydrate, and 0.008 gm. (⅛ gr.) codein.
Sig.—A teaspoonful every three hours if required to prevent coughing.

36. ℞. Elixir terpini hydratis cum he
4 c.c., or 1 fl. dr., representing 0.06 gr
0.0040 gm. ($\frac{1}{24}$ gr.) heroin.
Sig.—A teaspoonful every three hour

37. ℞.	Ext. grindeliæ robustæ fl.	f℥j;
	Tinct. lobeliæ Tinct. belladonnæ	āā f ʒij;
	Potassii iodidi	ʒiss;
	Syrupi	f℥j;
	Aquæ	q. s. ad. f℥iv.—M.

(Edwards.)

Sig.—One teaspoonful four times a day in the treatment of bronchial asthma.

CLIMATOLOGY

All catarrhal diseases are favorably influenced by an atmosphere free from dust. This is especially true of atrophic rhinitis, where proximity to large bodies of water and consequent moist atmosphere exerts a favorable influence. In chronic hypertrophic catarrh and bronchitis generally a dry atmosphere such as the sandy districts remote from large bodies of water is beneficial. Usually such localities are covered by evergreen and not deciduous trees, so that the atmosphere is saturated with piney odors. It is probable that temperature, provided there are few sudden changes, does not exert a very decided influence, although excessive and long-continued heat is debilitating and very excessive cold discourages the remaining out-of-doors for long periods of persons not in robust health. The altitude of a locality and the consequent rarification or condensation of its atmosphere exerts a considerable influence. Tuberculous individuals are generally benefited by residence in places where the altitude is considerable, but where there are extensive lung lesions it is important that the change from ordinary to high altitudes should be made very gradually because of the danger of pulmonary hemorrhage and for other reasons. Dr. Guy Hinsdale gives the following list of popular resorts as favorable for the treatment of diseases of the upper respiratory tract:

Chronic Catarrh of the Pharynx, Larynx, and Nose.—Summer: The Long Island and Massachusetts coast; the interior resorts of Maine, Moosehead Lake, Rangeley Lakes, Poland Spring; the White Mountains of New Hampshire; the Adirondacks, N. Y.; Pocono Mountains, Eagles Mere, Kane, Pa.; the Virginia Springs, the mountains of West Virginia and North Carolina; the southern coast of California, San Diego, Coronado, Santa Barbara; Castle Hot Springs, Arizona; Honolulu, Nassau.

Hay-fever.—The highlands of Ontario, comprising the Muskoka Lakes, the Lake of Bays, the Magnetawang district, Penetang, Midland, Honey Harbor, Georgian Bay, and Kawartha Lakes; Port Arthur and the neighborhood of Thunder Bay, Lake Superior; Yarmouth, Nova Scotia; Cape Breton; Charlottetown, Prince Edward Island; St. Andrews, Digby, Dalhousie, Campobello, New Brunswick, Eastport, Vinal Haven, Isle au Haut, Katahdin Iron Works, Moosehead Lake and Rangeley Lakes, Maine; Bethlehem, Maplewood, Profile, Twin Mountain, Mount Washington, Fabyans, Crawford, Jefferson, Dixville Notch, N. H.; Baker Island, Block Island, Nantucket, Mass.; the higher Adirondack resorts, *e. g.*, Undercliff, and Whiteface Inns, Lake Placid; Ampersand, Saranac Lake; Paul Smith's, Blue Mountain Lake, Raquette Lake, and Loon Lake; Beach Haven, N. J.; Put-in-Bay, Ohio; Marquette, Sault Ste. Marie, Mackinac, Mich.; Coronado Beach, Catalina *Island, Cal.*

Asthma, the Neurotic or Spasmodic Form.—Elevated sunny regions, *e. g.*, Colorado Springs, Manitou, Glenwood Sprints, Colo.; Castle Hot Springs, Ariz.; Hot Springs, Va.; Lake Placid, N. Y.; the White Mountains, N. H.; Kane, Pa. The higher elevations are contraindicated in aged persons.

Tubercular Laryngitis.—Florida and Southern California.

Chronic Fibroid Phthisis.—The interior Florida resorts in winter; the sand belt of Georgia, South Carolina, and North Carolina. The coast resorts of the southern Atlantic seaboard, including Atlantic City, are suitable for selected cases.

Pulmonary Tuberculosis.—Gravenhurst, Ontario; Ste. Agathe, Quebec; Long Lake, Gabriels, Ray Brook, Saranac Lake, Paul Smith's, N. Y.; Liberty, N. Y.; Rutland, Mass.; Sharon, Mass.; East Bridgewater, Mass.; New Canaan, Conn.; South Scituate, R. I.; Lakewood, Hammonton, Vineland, N. J.; Kane, Glen Summit, Pocono, Mont Alto, White Haven, Penna.; Ashville, N. C.; Southern Pines, N. C.; Aiken, Camden, S. C.; Thomasville and Summerville, Ga.; Palataka, Orlando, Enterprise, Fla.; San Antonio, El Paso, and Western Texas; Santa Fe, Las Cruces, Las Vegas Hot Springs, Fort Bayard, Fort Stanton, Silver City, and Albuquerque, New Mexico; Colorado Springs, Denver, Estes Park, Cañon City, Boulder, Colo.; Phœnix, Tucson, Tempe, and Prescott, Ariz.; the interior resorts, such as Redlands, Riverside, Monrovia, Pasadena, Mentone, Esperanza, Altadena, Santa Barbara, San Diego, Southern California; in summer the Rocky Mountains of Idaho, Montana, and British Columbia. In cases complicated with kidney disease, and in any advanced stage, high altitudes should be avoided, but hemorrhage is not a contraindication.

GARGLES

Gargles are of little value unless employed with more than usual care. Pope, by means of experiments with methylene-blue and other substances, demonstrated that as ordinarily performed gargling does not bring a medicament in contact with the fauces further back than the anterior pillars. When necessary to prescribe a gargle the patient should be instructed to close the nose tightly, throw the head far back, and gargle. By this method the probability of the fluid reaching the posterior wall of the pharynx is increased. Children cannot use a gargle, and rarely is it practical to teach a patient to gargle properly during an office visit. Gargles as ordinarily employed rarely reach the posterior wall of the pharynx and never the larynx. However, the following are cheap astringent gargles, and they may at some time be convenient to prescribe. The small amount of the gargle swallowed is, of course, effective.

38. ℞. Glycerol tannici.................... ℥j.
Sig.—A teaspoonful in a half-tumbler of water. Use as a gargle.

39. ℞. Alcoholis, 95 per cent.
Sig.—Dilute with 2 or 3 parts of water and use as a gargle.

40. ℞. Hydrogen dioxid, 15 volumes (3 per cent.).
Sig.—Use as a gargle to control oozing of blood after tonsillotomy. Dilute with 3 or 4 parts of water.

HEMOSTATICS

41. Adrenalin.

Adrenalin is the active blood-pressure-raising principle obtained from the suprarenal capsule of beeves or sheep. It is usually sold in 1 : 1000 solution, containing an antiseptic to prevent decomposition.

To produce local ischemia in mucous membranes preparatory to a surgical operation a 1 : 1000 solution is generally employed in the manner described in the article on Cocain.

When used in this manner nasal operations can be done without the loss of a drop of blood unless a vessel of considerable size be encountered. However, *secondary hemorrhage* occurring one or two hours after a nasal operation is more common when adrenalin has been employed, because the ischemia of mucous membranes so produced is followed by congestion when the effects of the drug have passed off.

The fact that applications of adrenalin to the nasal mucous membrane are followed by congestion as soon as the effects of the drug have passed prevents the remedy being entirely satisfactory in the treatment of hay-fever. The best results are obtained by somewhat frequent applications, say once in two or three hours, of a solution not stronger than 1 : 5000 or 1 : 10,000 or one of the oily preparations of adrenalin. However, in spite of every precaution, after a few days the condition of a hay-fever patient using local applications of adrenalin is in nowise improved, and is usually worse. At best it gives only temporary relief.

In some cases where even weak solutions of adrenalin are employed to prolong the effects of cocain, symptoms resembling atropin-poisoning occur. The nose is greatly congested and occluded. There are frequent attacks of sneezing and both nose and throat are hot and dry. To prolong the ischemic effects of cocain, antipyrin is safer than adrenalin.

The effects of adrenalin on the *heart* are similar to those of digitalis, with the difference that it acts with great rapidity, its effects are not as prolonged, and the blood-pressure-raising effect is more apparent. It slows the pulse and strengthens the cardiac systole while it shortens and renders diastole less perfect. It is a valuable cardiac stimulant and may be used hypodermically in heart failure during chloroform anesthesia.

Adrenalin is usually classed among the alkaloids because it is a nitrogenous compound forming salts with acids. It probably exists in the suprarenal capsules in combination with some organic acid. It is decomposed by prolonged contact with alkalies, and therefore should not be prescribed in conjunction with an alkaline nose-wash. It is a reducing agent and, therefore, should not be used in conjunction with hydrogen dioxid, permanganate, etc. It attacks many metals, tarnishing them and producing a black precipitate, therefore adrenalin solutions should not be allowed to remain for any great length of time in atomizers with metal tubes.

42. ℞. Acidi tannici }
Acidi gallici } .... *āā* gr. xx.—M.

Sig.—Add to a tumblerful of iced water and slowly sip the mixture, or gargle and swallow a portion every few moments until the bleeding stops.

Useful in controlling oozing of blood from the wound after tonsillectomy.

43. Emetin hydrochlorid has been used successfully for the control of hemorrhage after nasal operations and tonsillectomies. It does not

hasten clotting nor lower blood-pressure, but apparently contracts the capillaries. The dose is ½ gr., preferably given hypodermically.

44. ℞. Ergotin (aq. ext.)................... ʒj;
Ext. hyoscy. alc..................... gr. iij.—M.
Ft. cap. No. xx.
Sig.—One every three hours in hemoptysis.

45. ℞. Acidi gallici......................... ʒiss–iij;
Vini rectif.......................... ℥ss;
Glycerini........................... ℥iiiss.—M.
Sig.—A teaspoonful every two hours in hemoptysis.

46. ℞. Ol. terebinth........................ ℥j;
Muc. acaciæ......................... ℥iij;
Ol. gaultheriæ...................... ♏ij.—M.
Sig.—A teaspoonful every hour with water in hemoptysis.

47. ℞. Calcii chloridi...................... gr. xl.
Ft. cap. No. viii.
Sig.—One every hour until the bleeding is controlled.

The effects of calcium chlorid is to increase the coagulability of the blood, but if too large a quantity of the drug is given the opposite result is caused, namely, diminished coagulability. On this theory 2 or even 3 capsules (10 to 15 gr.) may be given at intervals of an hour in severe cases, but the amount of 80 gr. should not be exceeded in as many hours. Even in cases where the hemorrhage has not been completely controlled, if 80 gr. have been given within eighty hours, it is best to wait several hours before again resorting to the drug. However, in nasal hemorrhage resulting from diminished coagulability of the blood, better results follow the injection of 10 to 30 c.c. of horse-serum, or coagulose, thromboplastin, or coagulin ciba.

HYPNOTICS

48. ℞. Trional............................ gr. v–xx.

49. ℞. Veronal............................ gr. v–xx.

50. ℞. Paraldehyd........................ f℥ss;
Olei gaultheriæ..................... ♏x;
Pulveris acaciæ..................... ʒij;
Elixir simplicis.............q. s. ad. f℥iv.—M.
Sig.—½ to 1 tablespoonful in water every hour or two in the restlessness and insomnia following mastoid operations.

51. ℞. Chloral hydratis.................... gr. x;
Codein sulphatis.................... gr. ⅓;
Strychninæ sulphatis................ gr. 1/40.—M.
Ft. chartæ No. i.
Sig.—To relieve restlessness and insomnia after mastoid operations. Dissolve in half-tumberful of water and repeat dose in three hours if necessary.

After many severe operations on the nose, throat, or ear the patient for the first night or two will complain of pain, restlessness, and inability to sleep. This is especially true in neglected mastoid cases that have been operated on only after weeks of needless suffering and consequent demoralization and debility. In some such instances a hypodermic of $\frac{1}{4}$ gr. of morphin will be required in order to soothe the patient's sufferings. In other cases a reliable hypnotic produces the desired results. Under such circumstances the choice of a hypnotic in the patient's debilitated condition is by no means a matter of indifference, as all hypnotics are to a greater or less degree depressants. Sodium bromid (10 gr.) combined with chloral (5 gr.) repeated every hour, if necessary, yielded good results in the practice of the writer for several years. More recently, however, he has relied either on Formula 50 or 51. It should be observed that any possible depressant effect of chloral on the heart is guarded by the addition of a small proportion of strychnin in Formula 51.

HAY-FEVER

52. ℞. Pulv. salis Vichyani fact. efferv. (N. F.), ℥iv.

Sig.—Take a teaspoonful in a glass of water four times a day. Or, if the action of lithium is desired, the pulvis salis Vichyani factiti effervescens cum lithio (N. F.) may be prescribed.

53. ℞.	Hyoscinæ hydrobromatis	gr. $\frac{1}{100}$;
	Camphoræ monobromatæ	gr. ij;
	Sacchari lactis	q. s.—M.

Misce et tritura bene. Divide in tabulas vel capsulas No. xx.

Sig.—1 tablet or capsule at intervals of from ten to ninety minutes until the sneezing and running of the nose are controlled, after which 1 tablet may be taken every second, third, or fourth hours, as may be necessary to maintain the effect.

The following may be given in the same way:

54. ℞.	Atropinæ sulphatis	gr. $\frac{1}{50}$;
	Camphoræ monobromatæ	gr. v;
	Balsami peruviani	q. s.—M.

Misce. fac. capsulæ No. xx.

Dr. H. H. Curtis recommends the following tablet:

55. ℞.	Strychninæ arsenatis	gr. $\frac{5}{6}$;
	Atropinæ sulphatis	gr. $\frac{1}{5}$;
	Camphoræ	gr. xxv;
	Ipecacuanhæ	gr. v.—M.

Fiat massa in pilulæ No. c dividenda.

Sig.—One pill from three to six times a day.

56. ℞.	Heroin	gr. j;
	Atropinæ sulph	gr. $\frac{1}{25}$;
	Caffein cit	gr. xv;
	Salophen	gr. lxxv.—M.

Ft. caps. No. xv.

Sig.—One every two hours until 3 or 4 are taken and the nasal symptoms are alleviated, then 1 every three or four hours.

57. ℞.	Menthol	gr. j;
	Cocainæ hydrochlor.	gr. j;
	Orthoform	gr. v;
	Petrolati albi	℥j.—M.

Sig.—Apply to the nasal mucous membrane every two or three hours in acute rhinitis or hay-fever.

58. ℞. Acidi nitromuriatici (concentrated, freshly prepared), f℥j

Sig.—5 to 10 drops in a tumblerful of water one hour after meals and at bedtime.

In a proportion of cases of hay-fever the above formula will eliminate all symptoms of the disease within forty-eight hours. If after two or three days' use of the remedy there is no improvement in the symptoms, it is probable that nitromuriatic acid will prove useless, no matter how long continued.

Mineral acids were formerly used more frequently than at present in the treatment of diseases of the upper respiratory tract, 10 drops of dilute nitric acid every two hours in water being an old but usually effective remedy in the treatment of the *aphonia* of singers and orators.

In neurotics suffering from hay-fever much benefit sometimes results from:

59. ℞. Acidi hydrobromici diluti............. f℥ij.

Sig.—15 to 20 drops in a tumblerful of water one hour after meals.

Hydrobromic acid also yields in a majority of cases somewhat better results in the treatment of tinnitus than bromid of sodium or the mixed bromids.

FORMULAS FOR THE BOTTLE INHALER, CROUP KETTLE, ETC.

The steam from a kettle containing unslaked lime has been used for many years in the treatment of croup and diphtheria.

A *croup kettle* consists of a vessel usually with a long spout, to which a rubber hose is attached, by means of which steam is conveyed to the vicinity of a patient or under a croup tent erected over a bed. As the quantity of unslaked lime that will dissolve in water is not great, a piece of lime the size of a walnut is more than sufficient for several quarts of boiling water.

The following formula may be used with the bottle inhaler or added to the water in a teapot containing boiling water.

60. ℞. Tr. benzoin comp.

Sig.—Add ½ teaspoonful to a bottle inhaler half-full of hot water. Use the inhaler four or five times a day, or a coffee pot may be substituted for the bottle inhaler.

Useful in most forms of laryngeal inflammation. To the above formula, when requisite, an expectorant—ammonia muriat., fluidextract of senega, or ipecac—may be added. When it is desired to diminish expectoration and at the same time produce a sedative effect upon the laryngeal mucous membrane, fluidextract of belladonna or hyoscyamus

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in combination with the compound tincture of benzoin will yield satisfactory results.

61. ℞. Creosoti }
Alcoholis } .... āā f℥j.—M.

Sig.—6 or 8 drops on the sponge of a perforated zinc inhaler every hour or two. Where there is much irritating cough, 30 per cent. of chloroform may be added to the formula. The zinc inhaler should be worn upon the face as much as possible both day and night.

LOZENGES

Lozenges, when well made, are superior to cough syrups or gargles for the treatment of throat affections. They should be so made as to dissolve *slowly* and evenly in the mouth, thereby giving a more prolonged local effect than is possible with gargles or a spray, and a quicker and more pronounced result than can be obtained by a greater quantity of the medicament introduced into the stomach.

The favorite excipients seem to be black-currant paste and gelatin. Because of the length of time required for the drying of lozenges, druggists cannot quickly make them from the prescription of a physician, and it is, therefore, better to rely on the manufactured product of lozenge-makers, some of whom have national or international reputations.

A business man can carry a bottle of lozenges in his vest pocket and take one as required from time to time, when he would be embarrassed by the use of an atomizer.

However, it should be remembered that lozenges produce *both* a *local* and a *constitutional* effect and are only especially useful when this effect is desired.

Lozenges have in common with cough mixtures a notorious reputation of disordering the *stomach*. Most of the following formulas have been selected from the stock lozenges of manufacturers.

GUAIACUM AND ITS COMBINATIONS

"In cases of deep *tonsillitis* there is, fortunately, a remedy which if administered at the outset of the attack, will almost always cut short the crescent inflammation. This is *guaiacum*. I prescribe it as a *lozenge*. Taken in this way it seems to have a local as well as a constitutional effect."—Morell Mackenzie.

62. ℞. Troch. guaiac.

The lozenges are stimulant and alterative, and are capable of arresting recent inflammation of the tonsils.

These lozenges should contain 2 gr. of the resin of guaiacum and made in accordance with Mackenzie's formula, so as to be *entirely* soluble in the mouth. They are useful in the treatment of acute and subacute inflammation of the pharynx and acute follicular disease of the tonsils.

63. Troch. guaiac. comp.
R. Resin guaiac....................... gr. ij;
Potassii iodidi..................... gr. j.—M.

Stimulant and alterative; is especially useful when in acute inflammations of the tonsils there is a sensation of dryness, as the iodid increases secretion. A lozenge may be used every one or two hours.

64. Troch. guaiac. et acidi tannici.
R. Resin guaiac. . . . . gr. iss;
Acidi tannici . . . . gr. $\frac{1}{4}$.—M.
Sig.—A lozenge to be dissolved slowly on the tongue every one or two hours.

Stimulant and astringent, probably the most useful of the guaiacum lozenges in acute and subacute inflammation of the tonsils, pharynx, and larynx. Useful in the so-called "relaxed throats" of public speakers. The astringent action of the tannic acid is assisted by the alterative effect of the guaiacum.

65. Troch. guaiac. et acidi benzoici.
℞. Resin guaiac. . . . . gr. ij;
Acidi benzoici . . . . gr. j.—M.

Stimulant in nervomuscular weakness of the throat. It is somewhat useful in the treatment and the loss of control of the laryngeal muscles experienced by nervous actors, singers, and orators. In addition to the lozenge, $\frac{1}{30}$ gr. of strychnin or 1 dram of fluidextract of cocoa in 1 ounce of sherry wine may be prescribed, to be taken a few moments before going upon the stage or platform.

CAMPHOMENTHOL AND ITS COMBINATIONS

66. ℞. Troch. camphomentholis . . . . gr. $\frac{1}{10}$.
Sig.—A lozenge to be dissolved on the tongue every one or two hours, as required.

These lozenges check excessive discharges, and liquefy tenacious mucus. They are sedative, an antiseptic tonic to catarrhal conditions of the membrane, and a voice stimulant.

67. Troch. camphomenthol. et eucalypti.

℞. Eucalyptus rostratæ (red gum) . . . . . . gr. j;
Camphomenthol . . . . gr. $\frac{1}{10}$.—M.
Sig.—A lozenge to be dissolved on the tongue every one or two hours, as required.

A pleasant antiseptic astringent and sedative.

When greater anodyne effect is desired, in acute or chronic bronchitis, and in grip cough, the following is an efficient and reliable sedative:

68. Troch. codein comp.

℞. Codeinæ . . . . gr. $\frac{1}{10}$;
Camphomenthol . . . . gr. $\frac{1}{20}$.—M.
Sig.—A lozenge to be dissolved slowly on the tongue every one or two hours.

69. Troch. heroin.

℞. Heroin........................... gr. $\frac{1}{12}$;
Camphomenthol.................. gr. $\frac{1}{80}$.—M.
Sig.—A lozenge every two hours, if required, to relieve cough.

70. Troch. orthoform comp.

℞. Orthoform......................... gr. j;
Camphomenthol.................. gr. $\frac{1}{10}$.—M.
Sig.—One ten minutes before meals or as required, as a safe analgesic after throat operations and other painful conditions of the pharynx and larynx. (McConachie.)

COCAIN AND ITS COMBINATIONS

Instead of the orthoform lozenge, either of the two following may be employed in the dysphagia of tuberculous laryngitis, where greater analgesia is required:

71. Troch. cocain comp.

℞. Cocain hydroch.................... gr. $\frac{1}{16}$;
Extract. hyoscyami................ gr. $\frac{1}{10}$;
Extract. opii....................... gr. $\frac{1}{20}$;
Tincturæ aconiti.................. ℳss.—M.
Sig.—A lozenge a few moments before eating and every two or three hours.

This combination is of considerable value as an anesthetic and anodyne in the laryngeal lesions of phthisis and to control the paroxysms of asthma.

AMMONIUM SALTS AND THEIR COMBINATIONS

Ammonium salts have long been used in the treatment of pharyngitis and bronchitis. They may be given in the form of a lozenge for the local effect on the pharynx, but the lozenge should be so made that the ammonium salts do not dissolve more rapidly than the other ingredients of the lozenge.

72. ℞. Troch. glycyrrhiza comp.
Sig.—A lozenge every two or three hours.

Brown mixture lozenges should be so made that each lozenge corresponds to a teaspoonful of the well-known "brown mixture."

73. Troch. ammoniæ iodidi comp.

℞. Ammoniæ iodidi.................. gr. j;
Ammoniæ chloridi................. gr. ij;
Codeinæ........................... gr. $\frac{1}{6}$;
Morphinæ acetatis................ gr. $\frac{1}{25}$;
Ext. prunis virginianæ............. q. s.—M.
Sig. One every three hours as an alterative, sedative, expectorant.

MISCELLANEOUS LOZENGES

Some of the prescriptions under this heading are old favorites and have been popular with many physicians for years.

The next three lozenges may be given to children and adults who strenuously refuse any remedy having an unpleasant taste, as they are a pleasant confection:

74. Troch. mucilag. ulmi (mucilage of slippery elm).

℞. Mucilag. ulmi, q. s. facio troch. No. i.

75. ℞. Ipecacuanhæ.

These are large gum-arabic pastils of the same strength as the lozenges of the British Pharmacopœia. They are readily taken by children and exert the expectorant effects of ipecacuanha with the demulcent characteristics of the lozenge.

76. Troch. acidi borici compositæ.

℞. Acidi benzoici	gr. ss;
Acidi borici	gr. j;
Ext. erythrox. cocæ	gr. iss.—M.

Fiat troch. No. i.

This lozenge is sedative, demulcent, and of a pleasant taste. It is a valuable *voice lozenge* in cases of orators and singers of the neurotic temperament, who dread that their voice will fail them in the presence of an audience because of nervous muscular weakness. One should be slowly dissolved in the mouth every four hours. When used as a "voice lozenge" one should be taken one-quarter of an hour before using the voice and fluids should be avoided.

77. Troch. acidi carbolici.

℞. Acidi carbolici.................... gr. j.
Fiat troch. No. i.

This formula has long been a favorite as an analgesic, antiseptic lozenge.

MISCELLANEOUS

78. Contractile collodion.

Contractile collodion is sometimes applied to a cicatricial or atrophic drum-head to hold it in a more favorable position for hearing. For this purpose, after inflation by Politzer's method, only a small amount of the collodion should be painted upon the drum-head at one time, as there is some danger of producing myringitis if too large an amount of the remedy is painted on the drum-head at one sitting.

79. Phosphorated oil.

Formerly many ointments and solution
tympani for the relief of tinnitus and d

middle ear. Although this form of medication has largely been abandoned, phosphorus dissolved in olive oil, if applied to the drum-head, will sometimes bring about improvement of the hearing in deafness due to senility.

80. Chloroform.

81. ℞. Iodin.

82. ℞. Tincturæ iodini .... fℨj;
Chloroformi .... f℥j.—M.

83. Menthol.

The vapor of these substances is sometimes used as an application to the mucous membrane of the middle ear. They should be preserved ready for use in wide-mouthed, glass-stoppered bottles, so that the Politzer air-bag can be filled with their vapor by placing the nozzle of the bag within the neck of the bottle while the bag is expanding. Ether and chloroform vapor will sometimes penetrate into the middle ear through the eustachian tube when it is impossible to inflate the middle ear with simple air by Politzer's method or the use of the catheter.

84. ℞. Ac. carbol .... gr. xxx;
Ammon, carb .... ℥j;
Pul. carbo. lig .... ℥j;
Ol. lavend .... ♏xx;
Tr. benzoin co .... ℥ss;
Gum camphor .... ℨij.—M.
Sig.—Smelling-salts for acute nasal catarrh.

85. ℞. Paraffin .... ℨiv;
Albolene .... ℨv.—M.
Melt together in container surrounded by boiling water.
Sig.—For use as a subcutaneous injection for the correction of nasal deformities, etc.

For *subcutaneous injections* sterile paraffin, with a melting-point of 112° F., is usually employed. When the melting-point is much higher than this, it is not readily forced through a long needle and does not as readily penetrate the spaces of the cellular tissue. When the melting-point is much lower than 112° F. paraffin behaves more like ordinary oil, permeates the tissues more readily, and may enter a vessel and cause embolus.

Ordinary commercial paraffin whose melting-point is usually 128° F. may be reduced to a melting-point of 112° F. by adding 5 parts of albolene to 4 parts of paraffin, the mixture sterilized by boiling it and its container in water, and preserved for future use.

Thus prepared, the melted paraffin should be drawn into a suitable syringe (Fig. 62), the nozzle of which is then closed with its screw cap. The syringe with the paraffin it contains and the necessary needle are then sterilized by boiling in water. The syringe and paraffin contained in it are then cooled in sterile water, the screw cap removed, the needle screwed in its place, and the instrument is then ready for use.

86. ℞. Ext. cimicifugæ racemosæ........... f℥ij.
Sig.—15 to 20 drops after meals and at bedtime.

The above is sometimes useful in tinnitus. When effective its beneficial results are manifested within a few days. However, a rather large proportion of cases of tinnitus from chronic middle-ear catarrh are not benefited in the least by the use of cimicifuga.

87. ℞. Acidi carbolici..................... gr. iij;
Pulveris camphoræ }
Resorcini } .... āā gr. xx;
Acidi borici........................ gr. xxx;
Unguenti zinci oxidi................. ℥j.—M.
Fiat unguentum.
Sig.—Use twice a day as an external application in acne rosacea of the nose.

88. ℞. Pilocarpinæ hydrochloras............ gr. $\frac{1}{16}$–$\frac{1}{8}$.

Pilocarpin may be given hypodermically once a day in conjunction with potassium iodid three times a day by the mouth in effusion or hemorrhage into the labyrinth, tertiary syphilis, and traumatism involving the internal ear. The average dose of pilocarpin is about $\frac{1}{10}$ gr. hypodermically, but much larger amounts have been used with impunity. When administered for its action on the internal ear a sufficient amount should be taken to produce profuse sweating and salivation. The remedy should be continued a sufficient number of days to produce the desired result, unless the patient becomes greatly prostrated by its continued use or it is manifestly unavailing. When no improvement is manifest after a week's use of the drug it should be abandoned. It rarely is of use except in acute cases.

Pilocarpin is a drug whose action should be carefully watched, because serious and even fatal consequences have resulted from the injection of medicinal doses. Shoemaker reported a case where the patient suddenly expired after an injection of pilocarpin. In another case the same author states that the employment of $\frac{1}{3}$ gr. was followed by profuse diaphoresis, salivation, lacrimation, a discharge from the nose, sickness of the stomach, difficulty in breathing, and a sense of cardiac oppression. Internal and external stimulation caused the symptoms to disappear. Atropin is a physiologic antidote to pilocarpin.

Pilocarpin may be given by the mouth instead of hypodermically, but its effects are longer in manifesting themselves (fifteen to twenty minutes) and more uncertain. Politzer advises the injection of 6 to 8 drops of warm 2 per cent. solution through the eustachian catheter into the eustachian tube in sclerosis of the middle ear. Mendosa, in 3 cases, relieved urgent dyspnea from edema of the larynx by hypodermic injections of pilocarpin.

89. ℞. Tincturæ aconiti.................... ♏xxxvj;
Aquæ destil......................... f℥iss.—M.
Sig.—A teaspoonful in water every half-hour until three doses are taken; then every hour.

Useful in tonsillitis when the fever is high. Should be used after thoroughly evacuating the bowels with a saline.

90. ℞. Sodii salicylatis } .... āā gr. xx;
Potassii citratis }
Elix. adjuvanitis (N. F.)............ f℥iij.—M.

Sig.—Teaspoonful every two hours for a child of four years with tonsillitis.

91. ℞. Menthol........................ gr. xi¼ (0.75 gm.);
Cocain.......................... gr. iii¾ (0.25 gm.);
Chloral......................... gr. ii¼ (0.15 gm.);
Petrolatum..................... gr. lxv (5 gm.).—M.
Ft. unguentum.

Sig.—Ointment for neuralgia. Apply to the painful part and cover with a gauze bandage if the neuralgia is periorbital or hemicranial.

92. ℞. Hexamethylenamin (Urotropin)........ ʒiv.—M.
In capsulæ No. xxiv dividenda.

Sig.—One capsule three or four times a day is a prophylactic in threatened septic meningitis.

According to Johns Hopkins Hospital reports after therapeutic doses a sufficient amount of urotropin appears in the cerebrospinal fluid to exercise a decided inhibitory effect on the growth of micro-organisms; 30 to 60 gr. a day may be given in otic cases at the onset of meningeal symptoms. It is excreted also by the nasal and aural mucous membranes and may be given with advantage in commencing infections of these cavities.

93. The growth of epithelium over granulations is greatly facilitated by the application of scarlet red, either as a powder or ointment, of from 5 to 10 per cent. The use of a 5 per cent. ointment very greatly hastens the healing after the radical mastoid operations when skin-grafts are not employed.

94. ℞. Tinctura gelsemii...................... ♏xv–xx.

Morse states that 15 to 20 drops of the tincture of gelsemium taken internally will usually abort an acute coryza at once. The dose should not be repeated.

95. ℞. Chromii sulphatis.................. ʒij.
In capsulæ No. xxx dividenda.

Sig.—One after meals and at bedtime.

According to Echelberger and others chromium sulphate is a specific in simple hypertrophy of the thyroid gland (goiter).

OPHTHALMOCUTANEOUS DIAGNOSTIC REACTIONS IN TUBERCULOSIS

Technic and Course of the Cutaneous Reaction.—The skin is cleansed with green soap and alcohol. A space the size of a dime is then scarified as in ordinary vaccination and a 25 per cent. solution of Koch's old tuberculin rubbed in. Control vaccinations of 5 per cent. glycerin and ½ per cent. carbolic acid (the strength of these substances in tuberculin) are also made, because in certain individuals irritation follows slight traumatism of the skin. The positive reaction is manifested within a few hours and reaches its greatest intensity within twenty-four hours, as either a simple erythema or a more intense inflammation with the formation of papules. The reaction disappears, according to its intensity, in forty-eight hours or persists for weeks.

Technic and Course of the Conjunctival Reaction.—One or more drops of Koch's old tuberculin diluted with 5 parts normal salt solution is placed in the conjunctival sac. In from six to twenty-four hours the conjunctiva begins to redden and in milder reactions nothing more is noticed. However, there may be all the symptoms of a severe conjunctivitis. The test is contraindicated in individuals who have had disease of the ocular uveal tract, and the cutaneous test is generally preferable in children, as the conjunctival test sometimes sets up a phlyctenular conjunctivitis.

Failure to react in persons manifestly tuberculous indicates that the system lacks the power to combat the poisons of tuberculosis with its proteactive forces and, therefore, indicates an unfavorable prognosis. A large number of advanced progressive cases show no reaction to the tuberculin test.

FORMULAS FOR USE WITH NEBULIZERS

In order to be successfully nebulized a fluid must have sufficient viscidity. *Glycerin* nebulizes fairly well, but its nebulizing qualities are greatly improved by the addition of a small proportion of tincutre of benzoin. The benzoin should be added drop by drop with constant shaking of the bottle which contains the glycerin in order to evenly diffuse the benzoin through the glycerin, which becomes white and opaque from minute particles of benzoin suspended in the liquid. The mixture is comparatively stable and the benzoin contained in about 1 dram of the tincture can thus be suspended in 4 ounces of glycerin.

Ordinary bleached *petrolatum* oil or *albolene*, with or without the proportion of benzoin it can be made to dissolve, nebulizes fairly well.

Alcohol made viscid by the solution of one of the balsams, preferably benzoin, nebulizes fairly well. However, alcohol is somewhat irritating to the bronchial mucous membranes, and in use the product of a nebulizer containing an alcoholic solution is best diluted by the product of one containing a bland oily solution.

The alcohol evaporates somewhat rapidly during the process of nebulization, so that the fluid in the nebulizer becomes more and more concentrated, until finally the dissolved balsams are deposited within the nebulizer tubes and clog them up to an extent to prevent the instrument working unless more alcohol is added from time to time to replenish that which has evaporated.

Any substance can be nebulized successfully if reduced to a fluid state by solution in one of the above three liquids. Essential oils and camphors are best dissolved in albolene for nebulization; substances insoluble in oil, either in the glycerin mixture or in alcohol.

The following formulas may prove useful when used with a nebulizer. They should not be used with an atomizer, because the amount of fluid deposited on mucous membranes by an atomizer is many times greater than that derived from a nebulizer, and some of the following solutions are sufficiently concentrated to produce deleterious results if applied to the nose or pharynx by means of an atomizer. The fact that only a minute amount of nebulized fluid is deposited on the mucous membrane of the upper respiratory tract during the short time available for the treatment of a patient during an ordinary office visit probably accounts for the lack of enthusiasm manifested by most specialists for this method of treatment. The atomizer will probably always be the favorite instrument for applying remedies to the nose, pharynx, and larynx of office patients.

96.	℞. Fl. ext. ipecacuanha	f℥ss;
	Glycerini	f℥j;
	Tincturæ benzoini	♏xv.—M.

A stimulating expectorant is of considerable value in the early stages of bronchitis with scanty secretions and a sense of tightness across the chest; also in the early stages of coryza to increase secretions and render them more fluid. It relieves sensations of dryness in the nose and fauces from whatever cause. Asthmatic seizures are alleviated by nebulizing this formula with the addition of antispasmodics. Two fluidrams of the tincture of hyoscyamus, lobelia, and gelsemium, with 1 or 2 drops of chloroform, forms a suitable addition for this purpose. While being used alcohol will have to be added from time to time to prevent the fluid becoming too thick for nebulization.

97.	℞. Acidi tannici	ʒj;
	Glycerini	f℥j.—M.

Simple astringent useful in relaxed conditions of the mucous membrane of the upper respiratory tract.

98.	℞. Camphoræ	gr. x;
	Olei eucalypti	fʒij;
	Petrolati albi liquidi (albolene)..q. s. ad.	f℥j;
	Tincturæ benzoini	♏x.—M.

Sedative and lubricant. Useful as a diluent of other sprays, especially those containing alcohol.

99.	℞. Olei cinnamomi	♏xx;
	Olei eucalypti	♏xx;
	Menthol	gr. xl;
	Camphor	gr. lxxx;
	Petrolati albi fluidi	f℥viij.—M.

(Porch.)

Antiseptic, emollient.

100.	℞. Mentholis Camphoræ	āā gr. x;
	Eucalyptalis	♏v;
	Liq. albolines	f℥j;
	Ol. rosæ comp	♏v.—M.

Sig.—As an emollient to inflamed mucous membranes. (Byrne.)

For acute and subacute coryza, catarrh in the head passages, dry catarrh, ozena, and rhinitis. May be used regularly by public speakers, *singer, actors*, etc. A pleasant stimulant and protective.

101.	℞.	Chloretone	gm. 1;
		Camphoris	gm. 2.5;
		Mentholis	gm. 2.5;
		Ol. cinnamomi	gm. 0.5;
		Petrolati albi liquidi (albolene)	gm. 93.5.—M.

(McClintock.)

Anodyne, antiseptic, emollient. Useful in acute and subacute catarrh and bronchitis.

102.	℞.	Menthol	gr. xxx;
		Camphoræ	gr. xxx;
		Cocainæ muriatis	gr. xv;
		Tincturæ benzoini q. s.	f℥iv.—M.

Use with nebulizer for acute bronchitis, pneumonia, and all acute inflammatory affections of the air-passages. Alcohol should be added occasionally, as the fluid becomes too thick from evaporation.

103.	℞.	Olei caryophilli (cloves)	♏xxx;
		Creosotæ (beechwood)	ʒj;
		Olei picis liquidæ	ʒj;
		Iodini	gr. xxx;
		Tincturæ benzoinæ q. s.	f℥iv.—M.

Use with nebulizer for pulmonary and laryngeal tuberculosis, and in any condition requiring an active antiseptic. Alcohol should be added occasionally, as the fluid becomes too thick from evaporation.

104.	℞.	Olei cassiæ	♏xxx;
		Camphor-menthol	ʒij;
		Cocainæ	gr. viij;
		Tincturæ benzoini q. s.	f℥iv.—M.

Use with nebulizer for acute colds, sore throat, and in all cases of acute inflammation or congestion of the upper air-passages and middle ear.

OINTMENTS

105.	℞.	Ichthyol	ʒij;
		Adeps lanæ Petrolati āā	ʒj.—M.

106.	℞.	Unguenti hydrargyri Unguenti iodini Unguenti belladonnæ āā	ʒj.—M.

Both of the above ointments are effective applications in commencing mastoiditis and adenitis, etc. They should be smeared thickly over the parts and covered with waxed paper and a bandage. However, in spite of these precautions the ointments are liable to stain clothing, bed linen, etc. Therefore an iodin ointment which does not

vantages is sometimes preferable.

107. ℞. Hydrargyri oxidi flavi.............. gr. vj;
Olei petrolati..................... q. s.;
Petrolati........................ ℥j.—M.

Useful as an application in eczema of the auricle after all scabs and crusts have been removed by means of hydrogen peroxid. This ointment should be well rubbed into the inflamed tissues, and a few applications are sometimes sufficient to bring about a cure if care be exercised that purulent discharges from the tympanum are not allowed to come into contact with the skin of the auricle.

In eczema of the canal the following is sometimes more effective:

108. ℞. Acidi salicylici.................... gr. xxx;
Zinci oxidi }
Pulveris amyli }.................āā ʒvi;
Petrol. molis...................... ℥ij.—M.

109. ℞. Cocainæ hydrochloridi............. gr. xij;
Adeps lanæ...................... ℥ij.—M.

Useful in relieving the pain of subacute catarrh of the middle ear, furunculosis, etc. An ointment penetrates the skin of the canal more readily than a watery solution. For the relief of the pain of aural neuralgia or acute catarrh the ointment is simply placed as deeply within the canal as possible. For the relief of the pain of furunculosis the ointment is smeared upon a cone of cotton, which is wedged into the meatus with as much pressure as the patient conveniently can bear. The pressure, at first painful, ultimately relieves congestion and discomfort.

110. ℞. Phenol }
Camphoræ }................āā ʒss.—M.
Cocain hydroch. }

When these three solids are mixed a liquid results. One drop placed in contact with the drum-head is more quickly effective in easing the pain of acute otitis than cocain ointment.

PIGMENTS

111. ℞. Iodini............................ gr. v–xv;
Potassii iodidi.................... gr. xv–xlv;
Glycerini......................... f℥ij.—M.

112. ℞. Boroglycerid, 50 per. cent.

113. ℞. Acidi tannici...................... gr. xl;
Glycerini......................... f℥j.—M.

Formula 113 is an excellent application to the nasopharynx in the postnasal catarrh of adults. In children Formula 111 generally yields better results.

Formulas 111–113 may be used in the treatment of chronic hypertrophic rhinitis. The effects of the application vary with the amount of *the solution* used. No more of the iodin solution should be applied at one time than will produce a momentary sensation of discomfort. Applied inside the crypts of the tonsils by means of a cotton-tipped probe bent at a right angle it often brings about a rapid absorption of the hypertrophied glands. However, Battey's solution (see Caustics) usually yields better results.

DUSTING-POWDERS

There is a well-founded prejudice against the use of dusting-powders in the larynx; some authors stating that they never should be used, because when thrown from the powder-blower they strike a blow upon the inflamed mucous membrane and remain as a foreign body until dissolved or expectorated. However, as a matter of fact, the application of a powder to the laryngeal mucous membrane when gently and skilfully done is generally less disagreeable to the patient than the application of a fluid by means of a swab, and because of the prolonged action of the powder, as it slowly dissolves, sometimes produces better results. It should be borne in mind that a large amount of any powder thrown violently into the larynx frequently produces alarming spasm of the glottis.

114. ℞.	Menthol	gr. j;
	Sodii bicarbonatis	gr. ij;
	Magnesii carb. (levis)	gr. iij;
	Cocainæ hydrochloridi	gr. iv;
	Sacchari lactis	ʒiss.—M.

Sig.—Use as snuff every two or three hours.

The most marked relief follows the use of this powder, and a few applications will do much to abort acute rhinitis. Its effects are immediate, highly agreeable to the patient, and continue for a number of hours. The preparation should be dispensed in a tightly corked vial to prevent evaporation of the menthol, and a pinch should be sniffed up into each nostril every two or three hours or sufficiently often to maintain the nose in a patulous condition and limit the secretions. As the result of the use of the snuff the patient remains practically free from all nasal symptoms during the attack, and there is no danger of contracting the cocain-habit where the laws forbid the refilling of a prescription containing cocain.

115. ℞.	Argenti nitratis	gr. xxx;
	Zinci stearatis	ʒj.—M.

The above is useful in the treatment of atrophic rhinitis. It should be applied either as a snuff or with the powder-blower to the nasal mucous membrane; its use is followed by a moderate amount of smarting and increased nasal discharge.

116. ℞.	Zinci sulphatis	ʒj–iv;
	Sacchari lactis	℥j;
	Acaciæ	gr. x.—M.

117. ℞.	Alumnol	
	Sacchari lactis	

Useful as applications to the laryngeal mucous membrane in acute and chronic laryngitis. In cases in which bronchitis as well as laryngitis is present the powder should be applied during deep inspiration, in order that it may reach the trachea and bronchi.

118. ℞.	Iodoformis	gr. xxx;
	Acidi tannici	gr. xx;
	Bismuthi subnitratis	ʒj.—M.

Useful as an application in syphilitic and tubercular laryngitis.

119. ℞.	Bismuth. subnitratis	ʒij;
	Acaciæ	gr. x;
	Iodoformis	ʒss;
	Morphiæ sulphatis	gr. xx;
	Acidi tannici	gr. xxx.—M.

Useful as an application to the laryngeal mucous membrane in tubercular and syphilitic laryngitis, in the earlier stages of acute laryngitis, or in any laryngeal affection characterized by irritability and pain.

120. Orthoform.

This nearly insoluble substance has the property of producing analgesia when applied to exposed nerve-endings. It is, therefore, especially valuable as an application to irritable ulcers after they have been cleansed with Dobell's solution or hydrogen peroxid. Its anesthetic effects are increased by a previous application of a solution of cocain and persist for four or five hours. When insufflated into a tubercular larynx the powder produces a momentary smarting, followed by analgesia more or less complete, which persists as long as the powder adheres to an abraded surface or an ulcer. The powder possesses decided antiseptic qualities and promotes the healing of tubercular ulcerations. It has little effect upon the unbroken mucous membrane and its prolonged application to the skin in the neighborhood of ulcerations sometimes causes eczema.

A nurse or one of the patient's friends can be taught to insufflate orthoform into a tubercular larynx ten minutes before each meal, and in many instances thus secure complete relief from dysphagia. Orthoform is said to be non-toxic, and hence may be used locally in liberal quantities. In a certain proportion of cases anesthesin gives better results than orthoform in securing relief from pain. When ulcers exist, healing is best secured in insufflations of omorol, an insoluble albuminate of silver.

121. ℞. Pulvis acidi borici.

It is absolutely necessary that the powdered boric acid, insufflated within the tympanum as an application in the treatment of purulent inflammation, should be impalpable and free from all grit, as the sharp-pointed crystals of this substance are extremely irritating. A good plan is to test the powdered boric acid by rubbing a small quantity upon the lip with the tip of a finger, rejecting as unfit for use inside the ear those specimens that are "gritty."

It is important also that too large a quantity of boric acid should not be thrown into the ear at one time or it may form a hard mass and thus prevent the escape of discharges.

122. ℞. Acetanilid	ʒj;
Acidi borici	℥j.—M.

Sig.—Use as a dusting-powder to infected or foul-smelling wounds after mastoid operations.

Acetanilid, a derivative of anilin, is a white powder but slightly soluble in water and possessing decided antiseptic properties. It is, either alone or diluted with boric acid powder, a somewhat popular hospital dressing for superficial wounds "that are not doing well." It is especially useful in wounds after a mastoid operation where the discharges are foul smelling and the chiseled bone remains long uncovered by granulations. The powder, under such circumstances, should be thickly dusted into the wound. Iodin is liberated when the substance is brought into contact with organic matter and acts as an antiseptic.

123. Xeroform.

Xeroform or bismuth tribromphenol is an odorless synthetic product of the manufacturing chemists, and presumably has the sedative and astringent properties of bismuth combined with the marked antiseptic qualities of bromin and carbolic acid. As it has been given internally (5 to 7 gm. daily) it may be assumed that its local application to wounds and mucous membranes is absolutely devoid of danger of toxic effects. Upon wounded or inflamed mucous membranes it is an astringent, analgesic, and an antiseptic.

124. ℞. Aspirin (acetyl-salicylic acid).
Sig.—Apply with a powder-blower to the tonsils three times a day after gargling with an alkaline solution.

Dr. C. F. Kieffer, after investigation of the records of the army hospital at Fort Russell, Wyo., during ten years, states that 21.3 per cent. of the cases of acute articular rheumatism had a previous attack of tonsillitis, the time between the attacks averaging twenty-four days. He therefore treated a number of cases of acute tonsillitis by alkaline gargles and liberal applications of aspirin three times a day, with the result of great local comfort and an average duration of the disease of three days. However, the duration of the disease was not lessened by the internal administration of asoirin or salicylates.

PROTECTIVES

A useful formula as a protective to the nasal mucous membrane and for injection through a catheter into the middle ear is the following:

125. ℞. Menthol	gr. v;
Camphor	gr. xx;
Petrolati albi liquidi	f℥ij.—M.

Sig.—Use with an atomizer.

To the above, 10 drops of oil of eucalyptus, 2 drops
needles, or oil of cinnamon and oil of cloves may be add

SEDATIVES

126. ℞. Strontii bromidi.................. ʒj;
Sodii bromidi }
Potassii bromidi }.............. āā ʒij;
Essentia pepsini.................. f℥iv.—M.
Sig.—A teaspoonful in a tumbler one-half full of water after meals and at bedtime.

Useful in the useless cough of hysteric individuals.

127. ℞. Acidi hydrobromici diluti........... f℥ij.
Sig.—15 to 30 drops in a tumbler of water one hour after meals.

Hydrobromic acid also yields in the majority of cases somewhat better results in the treatment of tinnitus than bromid of sodium or the mixed bromids.

128. ℞. Sumbul.......................... gr. ij;
Camphor......................... gr. j;
Valeriani........................ gr. j;
Ext. hyoscyam.,................... gr. ss.—M.
Pil. No. i. Ft. pil. No. xxx.
Sig.—One every two hours.

Useful in cases where bromids are not advisable.

LOCAL SEDATIVES

129. Antipyrin.

A solution of antipyrin of 2 to 4 per cent. strength, when sprayed upon the mucous membrane of the nose or pharynx, has the power of contracting the capillaries and of producing an artificial anemia, which effect is maintained for from three to five hours. Solutions of antipyrin may be used with the atomizer in all acute inflammations of the mucous membrane of the upper respiratory tract. When used after the application of cocain to the interior of the nose a 4 per cent. solution will maintain the contractile effect of cocain upon the erectile tissue for several hours. When sprayed upon the nasal mucous membrane without the previous application of cocain a 4 per cent. solution gives rise to a smarting sensation, which, however, quickly subsides. Antipyrin solutions of the proper concentration applied to mucous membranes produce analgesia, but not local anesthesia.

From 25 to 50 per cent. solution is extremely useful as a daily application to the larynx in all forms of laryngeal inflammation. A brush or a dossil of absorbent cotton wrapped about a bent probe should be saturated with the solution and applied to the glottis. The application of antipyrin solutions of the strength of 50 per cent. and upward produces a burning sensation, quickly followed by a sensation of relief and comfort. Applied in this manner to the larynx antipyrin is not an anesthetic, but an analgesic, whose effects persist for several hours. In the strength of

5 to 10 per cent. solutions antipyrin is superior as an antiseptic to Van Swieten's liquid. In therapeutic doses antipyrin acts as an antispasmodic, diminishing the reflex excitomotor power of the spinal cord, and also as an analgesic, relieving the pain of neuralgia and migraine, whether due to reflex nasal irritation or to some other cause. Applications of strong solutions of antipyrin to the larynx should be supplemented by the patient inhaling five or six times a day the spray from an atomizer containing a 4 per cent. solution. The effects of antipyrin upon the heart should, of course, be borne in mind and the patient, if weak, should be cautioned not to swallow any portion of the spray deposited in the mouth, and not to use too large a quantity of the solution at one time, although in a 4 per cent. solution there is in 1 ounce only about 20 gr. of antipyrin, and much more than this amount in twenty-four hours probably could be used with impunity by most patients.

130. ℞. Iodoformi........................ gr. lx;
Ether.............................. ℥ij.—M.
Sig.—Use as a spray for the larynx.

131. ℞. Menthol.......................... gr. j;
Olei gaultheriæ.................... ♏iij;
Camphoræ........................ gr. xv;
Eucalyptol....................... ♏v;
Adrenalin (1 : 1000)............... ♏xxiv;
Petrolati albi }
Adipis lanæ } .... *āā* ℥ss.—M.
Sig.—Apply to the inside of the nose every two hours as a sedative in acute rhinits. (Byrne.)

TONICS

132. ℞. Hydrarg. bichlor.................... gr. ¼;
Acidi arseniosi.................... gr. ⅓;
Ferri pyrophos..................... gr. vj;
Quiniæ sulph....................... gr. xv.—M.
Ft. pil. No. xxiv.
Sig.—One after meals. (Seiler.)

Useful as a tonic pill in catarrh of the nose and throat, with a debilitated condition of the system.

133. ℞. Ext. bellad. fol. alc................. gr. iv;
Quin. sulph....................... gr. xxij;
Ferri sulph. exsic.................. gr. vij;
Strych. sulph...................... gr. ¼
Acidi arsenosi..................... gr. ⅕;
Oleoresinæ piperis................. ♏viiss.—M.
Ft. pil. No. xv.
Sig.—A pill three times a day.

In the treatment of the neuralgia of the ear, which is often a sign of defective nutrition and associated with anemia, the above combination is sometimes useful.

134. Elixir ferri quininæ et strychninæ phosphatum.
4 c.c., or 1 fl. dr., representing about 0.06 gm. (1 gr.) ferric phosphate, 0.03 gm. (½ gr.) quinin, and 0.001 gm. ($\frac{1}{60}$ gr.) strychnin.

Hematinic and nervine.

135. Elixir glycerophosphatum (N. F.).
4 c.c., or 1 fl. dr., representing 0.06 gm. (1 gr.) absolute sodium glycerophosphate and 0.3 gm. (½ gr.) calcium glycerophosphate.

Nerve tonic, reconstructive.

136. ℞. Hydrarg. chlor. corrosiv............ gr. ¼;
Arsen. triox...................... gr. ⅓;
Acidi hydrochloridi dil............. fʒiss;
Tincturæ ferri chlor............... fʒiv;
Elixir. calisaya............q. s. ad. f℥iij.—M.
Sig.—Teaspoonful in water after meals.

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